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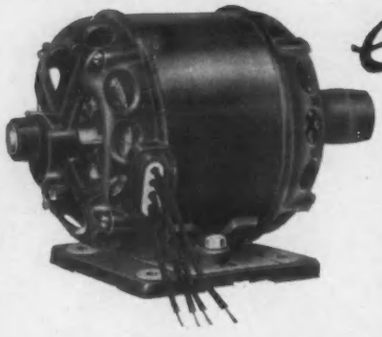

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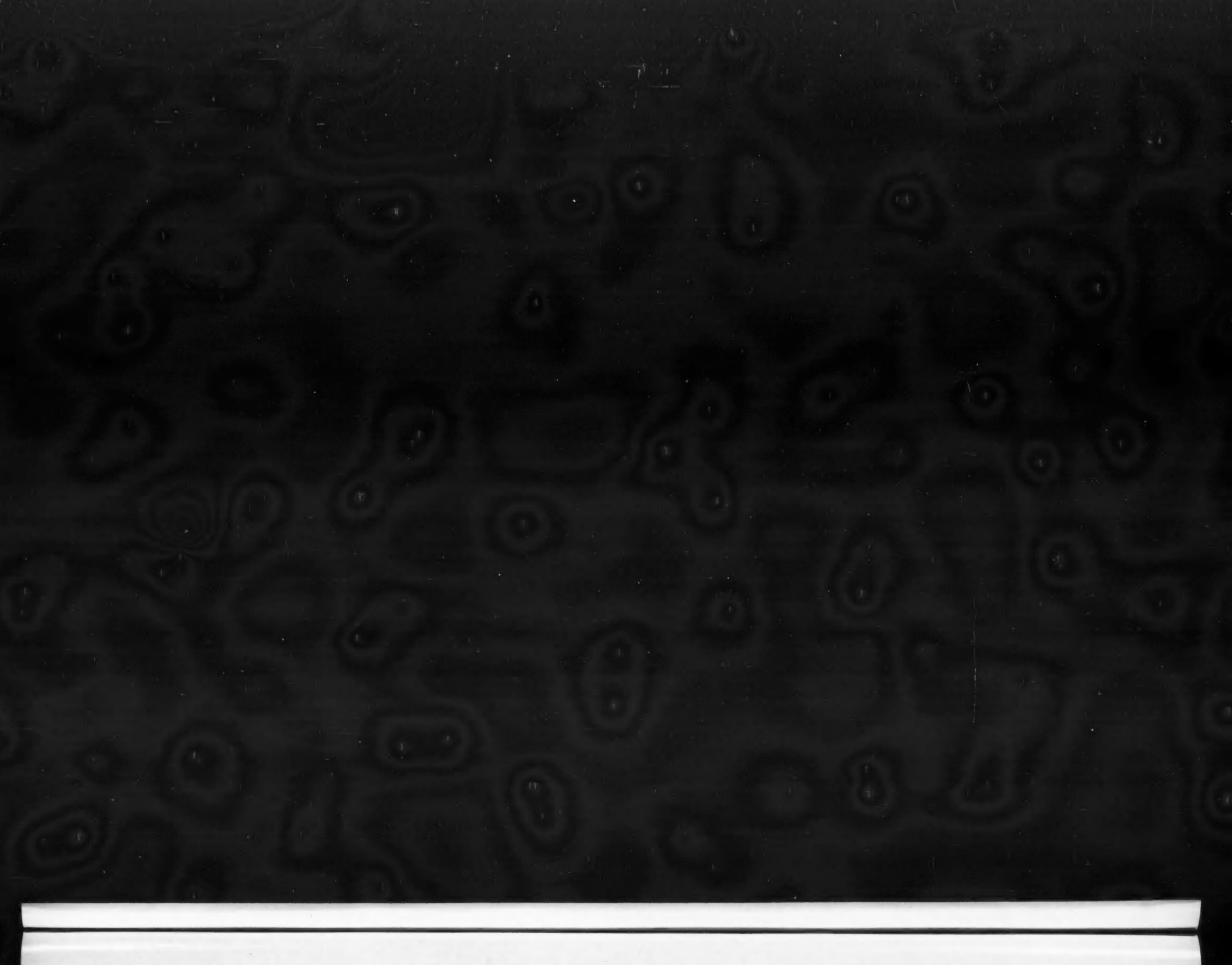

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VOLUME XXXVI SAN FRANCISCO, APRIL 1, 1916 NUMBER 14

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ILLUMINATION OF OAKLAND'S AUDITORIUM

BY ROMAINE W. MYERS.

(Details are here given regarding the electrical equipment and illumination of a large public building. The author is a consulting engineer of Oakland, California, who designed and supervised the electrical installation.—The Editor.)

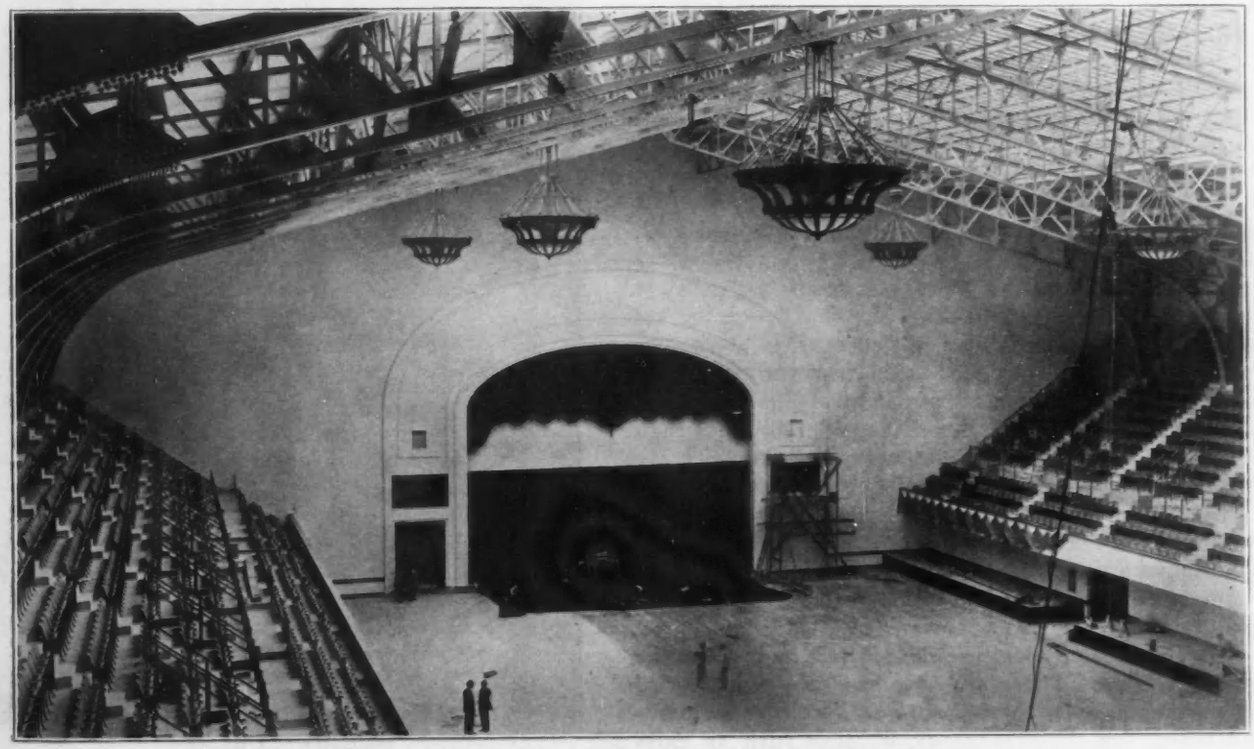
OAKLAND'S municipal auditorium in the central part of the city, faces Lake Merritt, with the Coast Range in the distance. It stands with wide open stretches on every side and a better site could not have been selected, both from the standpoint of beauty and that of utility. The building cost, exclusive of the grounds, $1,000,000. It is of reinforced concrete.

The main facade on the north side facing the lake is faced with granite with seven niches, each decorated with bas reliefs. It has a length of 400 ft. and a width of 200 ft. There are three stories and a basement.

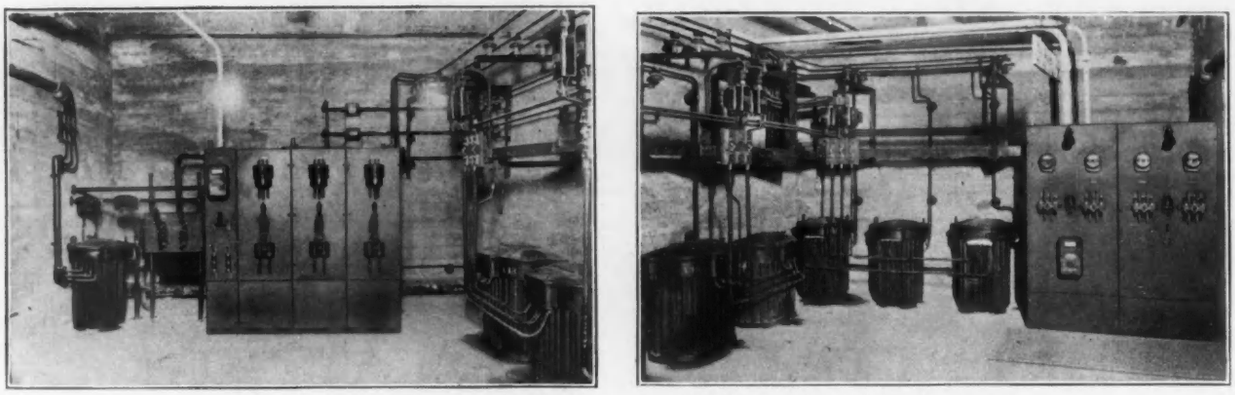
The interior of the building, on the first floor, is divided into an arena and a theatre, these having a total seating capacity of about 12,000. The arena is separated from the theatre by a stage, which can be thrown open so as to be used in common by both, or divided by a steel asbestos curtain, thus making it into two stages for use with either arena or theatre section. The arena has a clear floor space of 214 by 117 ft. and a seating capacity including balcony of nearly 10,000 people.

The theatre section has a seating capacity of 2000 and was especially designed for grand opera, theatrical productions, etc. The theatre has an orchestra pit for 100 musicians and dressing rooms for the accommodation of 200 people. There are separate entrances and ticket offices for both theatre section and arena.

The arena and theatre balconies are reached by wide inclines rising by easy stages. The main cor-



Night Picture of Arena, showing Suspension of Semi-Indirect Fixtures.



Service Room, showing 13,000 volt Service Switch-board and Transformers.

ridor extends the full length of the building from which corridor the exits in the niches open. Between recesses of these niches are spaces utilized for exhibition booths.

In addition to the main arena and theatre section there are several rooms for smaller gatherings: committee rooms, a ball room and an art gallery. The basement space is used for storage rooms, heating and ventilating apparatus, electric lighting and power switchboards, machinery, and the balance is for use in conjunction with the arena for live stock, horses and kennel clubs and sportsmen's shows in general.

Electrical Equipment.

The electric light and power service enters the building underground in 3 in. conduits. This consists of two 3-phase 4400 volt lead covered cables, one connected to the Pacific Gas & Electric Company's hydro-electric system and the other to the steam system. This is done to insure continuity of service in case of the failure of one. There is also a 500 volt direct current service for elevators. There are few elevators in the building, as most of the floors are reached by inclines. The unusual engineering point of the service conduits is the fact that they were placed in "made" ground, the lengths being staggered and bound together by steel straps, thus making a continuous steel construction.

The service cables enter a fireproof service or transformer room, the alternating current services terminating in 13,000 volt oil switches equipped with the usual relays. These switches were installed for this high voltage so as to take care of the possible change in primary voltage to 11,000. From the oil switches the current is transmitted on insulators supported on an angle iron rack to the transformers, there being ten, having a capacity of 330 kw. This is enough for all ordinary purposes but is considerably less than the capacity of feeder cables in switchboards which are installed for a total capacity of over 700 kw. Provision has been made for setting more transformers in parallel when the occasion demands it. There are also two 3 in. spare conduits from the transformer room to the main switchboard for additional cables that may be required.

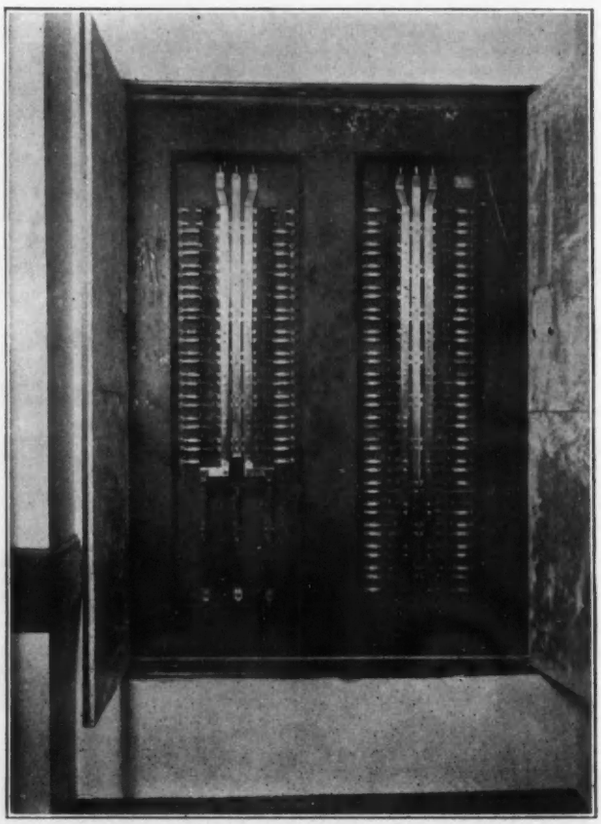
In the service room are the electric meters for the entire building. These are on a separate switchboard upon which are also located automatic control switches and relays for the emergency lighting such as exits and corridors. These automatically throw the current on to another service in case of the failure of one.

From the transformers in the service room all the current, except that used for emergency lighting, is transmitted by sixteen 500,000 c.m. and five 300,000 c.m. cables to the main switchboard. This switchboard is in a concrete room under the stage.

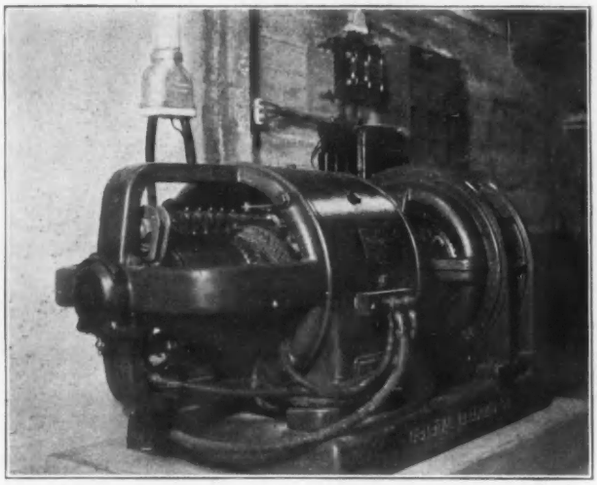
The main switchboard consists of nine panels of marine finished slate upon which are mounted switches and circuit breakers for transmitting 500 volt direct current to elevators, three-phase a.c., 220 volt for motors and 220-110 volt single-phase a.c. for lighting to the stage switchboards and various panels in the building.

These panels exclusive of the arena and stage switchboards number twenty-two, with 436 circuits.

Direct current for stage, moving pictures or search lights is supplied by a 30 kw. 125 volt General



Typical Panel Board.



Motor Generator Set, Main Switchboard Room.

Electric motor generator set in the main switchboard room. Also in this room is the arena floor switchboard. This board has a capacity of 500 kw. which is divided into three-phase 220 volt, single phase 220-110 volt three-wire and 125 volt direct current panels for supplying light and power to the arena floor.

There are twenty large junction boxes 18 in. in diameter and 8 in. deep set in the arena floor at various intervals. These junction boxes are connected together both longitudinally and transversely by means of a mass of 2 in. conduits to a large can in the rear of the arena switchboard. These conduits have no wire pulled in, the object being to provide a raceway to various points on the floor so that in case of an electrical or machinery show, it would be easy to pull in cable and connect to any current desired. Along side of these junction boxes are also placed small junction boxes for telephone and signal purposes. These are also connected together in a similar manner. A trap in the hardwood floor successfully conceals the junction boxes from view.

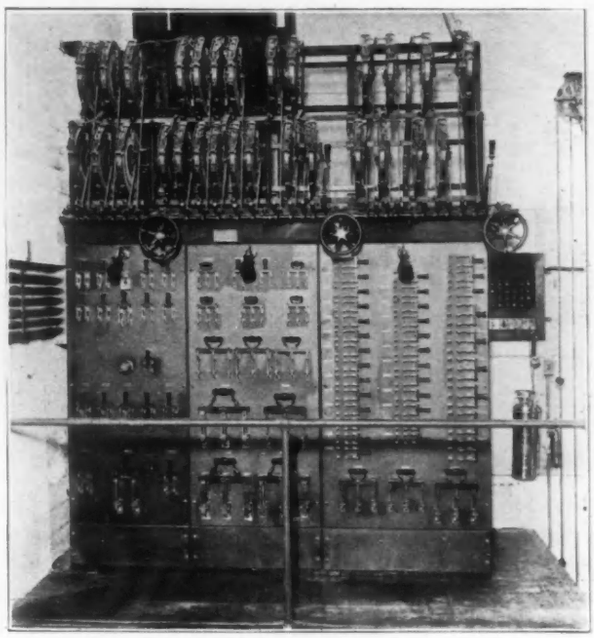
The center of the arena floor is provided with four No. 0 cables for moving picture machines. There also are twenty-two receptacles under the gallery rail and fifty-five receptacles on the main roof trusses—all of these on separate circuits—for decorative or other uses.

The arena stage switchboard and the theatre stage switchboard are on the same side of the stage directly over the main switchboard in the basement. This was economy from the electrical point of view, as it saved considerable copper.

The stage switchboards are similar, both being provided with grand master, stage and house light master, red, white and blue master and direct current master switches.

All fuses are on the rear of the boards and easily accessible. The border and pockets for theatres and arena are interchangeable, being connected by double throw switches.

In providing the light for the stage, it is necessary to take into consideration the fact that for persons in the rear of the balcony of the arena, being at a distance of over 250 ft., the amount of light used would be necessarily more than the ordinary theatre stage. With this idea in view, there were five borders in-



Theatre Stage Switchboard.

stalled, each border having reds, whites and blues consisting of three hundred and twelve 40 watt lamps; the foots having two hundred and eighty-eight 40 watt lamps. The combined capacity of pockets on stage is over 2500 amperes. The borders, foots, strips and pockets are equipped with a full set of Cutler-Hammer dimmers. Monogram act announcers are installed for each stage.

The stage manager has been provided with signals and telephones to various parts of the house and dressing rooms. The wall 'phones are Holtzer-Cabot and of a durable type, being fool proof and thief proof, which is a desirable feature in a building of this character.

The arena, including the balconies, has an area of 46,000 square feet. This is illuminated by a set of the largest semi-indirect fixtures ever built and placed in one room. These fixtures are 10 ft. in diameter, weigh over 3800 lb. each and are suspended about 60 ft. from the floor. Type "C" lamps consuming 44 kw. are used in the eight fixtures. It was necessary to provide a reflecting and diffusing ceiling for each fixture, as the clear glass ceiling of the arena could not be used for this purpose.

The average illumination upon a reading plane of the arena floor is 3.2 foot candles. The diffusion of light in this room is particularly pleasing. In a recent athletic tournament in which there were more than 2000 participants, an indoor baseball game, a basket ball game and a 200 yard relay race were held simultaneously. These games were all played with apparently the same ease, as far as seeing is concerned, as in the daylight.

The theatre is illuminated by a center skylight, behind which are placed type "C" lamps and special mirrored reflectors. The ceiling decorations are brought out by means of lamps placed in a cove, some of the lamps being installed in a Mohrlite trough and others in parabolic reflectors.

The theatre has two moving picture rooms, one

Night Picture of Diffusing Sash in Theatre.

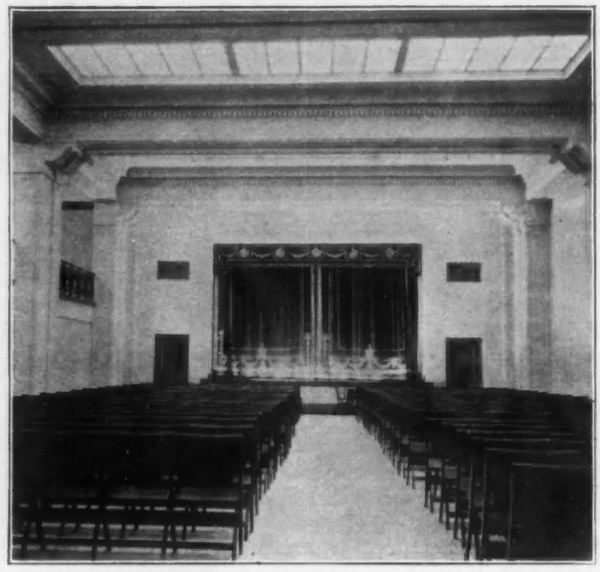
in the first and one in the second gallery. These are equipped with two Powers Cameragraph No. 6 A moving picture machines with stereopticon attachment. Each room has three 100 ampere and two 50 ampere receptacles, also 10 ampere receptacles for motors for machines and rewind apparatus.

The main corridor on the north side of theatre and arena is illuminated by 400 watt Mohrlite semi-indirect units which give an average illumination on the reading plane of 4.7 ft. candles. In the exhibition booths of this corridor there are also circuits feeding twelve 50 ampere and twelve 10 ampere receptacles, thus making provision for the display of electric heating, small motors or other electric apparatus at these places. The main and second floor lobby of the theatre is illuminated by 200 and 150 watt Parian glass semi-direct fixtures. The illumination averages 2.6 and 2.5 foot candles respectively.

All inclines are illuminated by shallow Alba bowls 2½ in. by 10 and 12 in. set in cast bronze ceiling flanges. It was necessary to provide a fixture for a minimum length due to the low ceiling height of the inclines.

On the first floor are also shower rooms, ladies' rest rooms, a press room with telephone and telegraph connection facilities for large conventions, also a kitchen which is provided with electric current for electric cooking on a large scale.

Night Picture of Main Corridor.



Art Gallery, showing Diffusing Sash.

On the second floor are committee rooms, smokers, and ladies' dressing rooms and smaller assembly rooms, the assembly rooms being equipped with facilities for moving pictures.

On the third floor is the art gallery and ball room. The art gallery is a room 36 by 110 ft. and is illuminated by Holophane reflectors above a skylight. Provision is made along the picture moulding for a large number of receptacles. These are for the individual lighting of pictures. The ball room is finished in a French gray tone and has a seating capacity of over 600 persons. One of the features of the room is a balcony overlooking the dancing floor. It is also equipped with a stage complete with curtain, border and foot lights and dressing rooms adjoining the stage. It has a kitchen which is fully equipped with a large General Electric Company electric range. The room is illuminated by Holophane reflectors placed above moss amber glass. This glass is noticeably free from spots, producing an excellent diffusion of light throughout the room. This is noticeable from the night photograph shown in this article. The illumination on the reading plane averages 2.7 foot candles. The ballroom opens out into an open air promenade and roof garden which runs the entire length of the auditorium and overlooks the lake and surrounding hills. In the center of this promenade there are two 100 ampere receptacles fed by No. 4/0 cables from the motor generator set in the main switchboard room. This current is for the purpose of searchlights or any other spectacular lighting effects that might be produced on the roof. For instance, they were used to furnish current for six 500 watt General Electric flood lighting projectors thrown on a pennant sixty feet long bearing the words "Ad Masque February 14th." This pennant was suspended from a steel cable 300 ft. long between the flag poles on the roof of the building.

The architect of the building was John J. Donovan, the consulting architect being Henry Hornbostle, and the electrical contractors NePage-McKenny Company.

IRRIGATION PUMPING BY ELECTRIC POWER

BY GEO. D. LONGMUIR.

(This interesting record of electric irrigation pumping in the Columbia River valley gives comparative costs which provide an excellent argument for power salesmen. While it deals specifically with conditions met by the Pacific Power & Light Co., from whose Bulletin this article is taken, it is applicable to many other districts.—The Editor.)

To my mind no method of demonstrating the feasibility and costs of irrigation pumping by electric or other sources of power, is as satisfactory as reciting the actual practices and results obtained in districts where such methods of irrigation are established. The following discussion will be devoted for the greater part to the actual irrigation pumping by electric power in the Columbia River valley, its resultant costs and benefits and reciting the various factors to be taken into consideration by prospective farmers and intending purchasers of pumping plants.

The Columbia River valley is favored with an inexhaustible supply of water, consequently no difficulty is experienced in obtaining water for irrigation from the rivers or from dug wells. The irrigable land in that valley, and I speak only of that portion lying between Beverly, in Grant county, and Wallula in Walla Walla county, exists on both sides of the Columbia River and totals at least 200,000 acres under a one hundred and fifty foot lift, which elevation I consider entirely practicable for pumping.

To date only a small area of this valley is being irrigated, either by gravity canal or pumping plants, but its possibilities of development, at a low cost per acre foot of water pumped, are extensive.

Before electric power was available the farmer used either a steam or gasoline engine to pump water, but at no time did he consider such a prime mover anything but temporary, as the costs of fuel in the remote districts were prohibitive and the labor of looking after his plant usually took the greater part of one man's time. Today, in being served with electric power, the farmer knows that he has at his command a source of power that is economical and dependable and in many cases he figures his power contract an asset, more valuable than any water right which he might be able to purchase.

The start in supplying power for irrigation pumping was made in a very small way, and only after careful consideration had been given the subject of rates, applicable to that class of business. Fundamentally a power company must be amply compensated for the investments which it makes for the sole use of the farmer and the revenue received must cover the fixed, or investment charges, and also the operation expense incurred in serving him. The rate established at that time, by our company, took into consideration general conditions of equity between the central station and the customer and was made up on a so-called load factor basis. This basis takes into consideration two separate elements, one taking into account the connected load, or maximum demand, of the customer's apparatus, the other, the energy used, or in other words the actual hours of use of such apparatus. We still had to bear in mind, however, that this rate must be sufficiently low to be attractive to the farmer, and at the same time, to show a saving by its use over all other sources of power competing with us. To accomplish this at the start meant that this class of business had to be operated at a loss for several years or until such time as we had secured a density or volume of business which would warrant the construction of the lines already installed.

The following rate, known as Schedule G, was adopted:

A fixed charge of $12.00 per year per rated horsepower of customer's connected apparatus, to be paid in equal monthly installments, plus the following meter rates for energy used during each month:

First 30 kw.-hr., per rated kw. of connected apparatus, 3 cents per kw.-hr.

Next 30 kw.-hr., per rated kw. of connected apparatus, 2 cents per kw.-hr.

Next 120 kw.-hr., per rated kw. of connected apparatus, 1½ cents per kw.-hr.

Next 240 kw.-hr., per rated kw. of connected apparatus, 1 cent per kw.-hr.

All over 420 kw.-hr., per rated kw. of connected apparatus, ½ cent per kw.-hr.

The above rate is applicable to plants of 25 h.p. and less and the same rate applies to plants over 25 h.p. with the exception that the running charges are based upon maximum demand instead of connected load and discounts are given after certain quantities are used. We also have a flat rate of $42 per horsepower per year where continuous operation is desired, but as 95 per cent of the small plants in my district use the metered schedule this discussion will be confined to Schedule G.

That the general construction of this rate is fair, is obvious, for it reproduces for the customer the same conditions of cost that would obtain if he were to install and operate his own generating plant. For example, a customer with a demand, say of 20 h.p. would, if desiring to supply his own needs, have to install a plant capable of meeting that demand at all times. Hence, the plant or investment charges would be proportional to the maximum demand. Furthermore, such operating costs, as labor and fuel would be proportional to the number of hours in which the demand would be used. In other words, whether the owner of an isolated plant, be it large or small, gasoline, steam or electric, knows it or not, it is nevertheless a fact that his plant serves him automatically at a load factor rate, simply because such a rate represents actual conditions of cost.

We have now been in the irrigation business a full five years and we have made substantial progress in arriving at a satisfactory solution of irrigation pumping, best adapted to that valley. During the first two or three years the conditions in the valley, under which we were forced to operate, were chaotic, in that inefficient pumping plants had been sold our customers and in many cases the outfits purchased were much too large for their particular needs, the result being a prohibitive cost for power per acre irrigated and consequent dissatisfaction with the service. To correct these mistakes the company made careful study of the situation and brought into the field representatives of standard pumps, who sold outfits under absolute guarantees of performance. The power company, at a great deal of expense to itself, installed high class units in various districts to show the farmer that with a standard pump giving reasonable efficiency very satisfactory results would obtain in operation costs. At the same time we put into the field an irrigation engineer, whose sole duty was to call upon the various farmers and aid them in every possible way, either in purchasing their outfit, or in its subsequent operation.

The result is today we have very little of the trouble we had the first few years and the plants, as a whole, are giving good satisfaction and operate with a reasonable degree of efficiency.

The farmer contemplating the purchase of a pumping plant will first want to determine the capacity of his plant and its period of operation. This capacity will depend upon the number of acres to be irrigated, the depth of water the land requires during the season, and, in the Columbia River valley, particularly, the amount of water necessary during the two months of July and August. I have found that the average farmer in that district pumps at least 40 to 45 per cent of his season's water during those two months. It will be seen, therefor, that no pump capacity, smaller than that needed to supply the necessary water running continuously for these two months, should be considered. This rule governing the capacity of a pump will hold good in nearly all cases on the large units, but it has its objections to a farmer with a small plant and a relatively small area to irrigate. While continuous pumping to him might mean a saving in power cost it would be more than offset by the increased labor costs of handling a small head of water, also the additional losses incidental thereto. Upon the smaller units, therefore, the farmer must decide for himself as to the size of his outfit and he usually does so by hitting a happy medium.

By far the most commonly used pump for raising irrigation water is the centrifugal and as, with very few exceptions, the centrifugal is the choice of all those in my district, so it will be with other in different localities where the choice lies between that and a power plunger pump, the determining factors being the capacity required and the height of lift. Centrifugal pumps owe their popularity chiefly to their simple design, small first cost and the fact that they require little attention while running. The larger sizes will, if driven at high speed, usually care for lifts as high as 100 ft. and the smaller sizes from 50 to 75 ft. In every centrifugal pump the number of revolutions of the runner or impeller has its exact relation to the elevation against which the pump is working, and for every lift there is a speed at which the pump will work most efficiently. Therefore it is of utmost importance in purchasing a pump that the exact head be given, which will include the friction as well as the vertical head. While dwelling upon the efficiency of the pump, I will add that its efficiency can be increased by reducing the friction in the suction, and discharge pipe. As few bends as possible should be used and these should be of a long radius ell. The discharge pipe should be at least one and a half times larger than the diameter of the pump outlet, and where long runs are necessary a pipe of even larger size will be economy. I have known of cases where through friction losses alone due to small pipes, twenty to twenty-five per cent more power was required.

In calculating the costs of operation of the various plants, I take into consideration all of the costs, including investment and depreciation charges, as well as operating and maintenance. To compare these costs with the cost of irrigation under gravity or pumping projects it is first necessary to take into consideration the purchase price of the water right. For example, a man buying a water right of 30 inches per year and paying for it $75 per acre with a maintenance charge of $1.50 per acre, really has a total cost of $6 interest at 8 per cent on $75 plus $1.50, or $7.50. This makes his cost $3 per acre foot.

One of the first irrigation power customers we obtained in the Kennewick valley was the owner of a 120 acre tract about one and one-half miles east of Kennewick. This plant has now been in successful operation five years, and the owner has irrigated the entire 120 acres each year, and has confined himself to raising alfalfa principally, although he has fruit trees planted which will come into bearing in three or four years. This ranch obtains its water supply from a well 28 ft. deep, 22 ft. of which is curbed, and at no time has a shortage of water ever existed.

Cost of digging well	$ 200.00
Curbing and concrete	100.00
Pump house	350.00
Suction and discharge pipe, pump and motor	750.00
	$1,600.00

Investment per acre, $13.33.

Operating Costs.

Electric power charges, 1915	$ 611.70
Interest 8 per cent on investment	128.00
Depreciation 7 per cent on last 3 items	98.00
Oil, repairs and attendance, yearly average	10.00
Total cost	$ 847.70

Summary of Costs and Operating Characteristics.

Average height water pumped (feet)	26
Horsepower in-out to motor	14.3
Gallons pumped per minute	1050
Number of hours plant operated during season	3470

Total acre inches pumped, 8075, or 67 inches per acre.
Total cost per acre, $7.
Cost per acre foot of water pumped, $1.51.
Plant operated upon an 80 per cent load factor.

About two miles east of Kennewick, we have a customer irrigating a small tract of twenty acres, and growing strawberries, alfalfa, corn and garden truck, and this man is frank to state, that during the 1915 season, his place netted him $1400, over and above all expenses. He has a three horsepower motor, direct connected to a 3 in. centrifugal pump, and lifts 200 gallons per minute from a well to an elevation of 27 ft.

Cost of digging well together with concrete curbing	$ 200.00
Pump house	50.00
Pump and motor installation	325.00
Suction and discharge pipes	50.00
Total investment	$ 625.00

Investment cost per acre, $31.25.

Operating Costs.

Electric power charges, 1915	$ 93.75
Interest 8 per cent on investment	50.00
Depreciation 7 per cent on last 3 items	29.70
Oil, repairs and attendance	5.75
Total cost	$179.20

Summary of Costs and Operating Characteristics.

Average height water pumped (feet)	27
Horsepower in-out to motor	3.6
Gallons pumped per minute	300
Number of hours plant operated during season	1175

Total acre inches pumped, 787, or 39.3 inches per acre.
Total cost per acre, $8.96.
Cost per acre foot of water pumped, $2.75.
Plant operated on 28 per cent load factor.

This 3 h.p. plant, operated 125 hours in April; 108 hours in May; 305 hours in June; 319 in July; 222 in August; 85 in September, and 11 in October, and you will note that during June and July, over 50 per cent of the season's water was pumped.

Two miles west of Pasco, there is a large dairy and hog ranch which has had 170 acres under cultivation, consisting mostly of alfalfa and fruit. For five years previous to 1915, this ranch used a gasoline engine to pump all of its water, and for four years efforts to get the owner to use electric power were unavailing, and we always met with a response that our rates were too high. Early in 1915, however, we secured a power contract from this customer, and at the beginning of

the irrigation season a 25 h.p. motor direct connected to a De Laval pump was installed. The following information will be interesting, especially in view of the comparisons which I will draw between the costs of 1915's operation with electric, and 1914 with gasoline. This plant takes its water supply from the Columbia River, and the pump house is located just above the average high water mark.

Cost of concrete pit and pump house	$ 219.00
Pump and motor	743.00
Suction and discharge pipe, estimated	1,200.00
	$2,162.00

Investment per acre, $12.70.

Operating Costs.

Electric power charges, 1915	$ 975.10
Interest 8 per cent on investment	173.00
Depreciation 7 per cent on first two items	67.34
Oil, repairs and attendance	44.10
Depreciation 12 per cent on pipe	144.00
Total costs	$1,403.54

Summary of Costs and Operating Characteristics.

Average height water pumped (feet)	75
Horsepower in-put to motor	28
Gallons pumped per minute	900
Number of hours plant operated during season	3268

Total acre inches pumped, 6950, or 41 inches per acre.
Total cost per acre, $8.25.
Cost per acre foot of water pumped, $2.41.
Plant operated upon 75 per cent load factor.

The previous year, or in 1914, the investment and operating costs of the gasoline outfit, was as follows:

Cost of engine, pump and house	$3,000.00
Suction and discharge pipe estimated same as electricity	1,200.00
Total investment	$4,200.00

Investment per acre, $24.65.

Operating Costs.

Gasoline and oil, 1914	$1,290.00
Labor attendance	510.00
Repairs, 1914	400.00
Interest 8 per cent on investment	336.00
Depreciation 7 per cent, pump and house	35.00
Depreciation 12 per cent, gas engine	300.00
Depreciation 12 per cent on pipe	144.00
Total costs	$3,015.00

Summary Costs and Operating Characteristics.

Average height water pumped (feet)	75
Horsepower of engine	45
Gallons pumped per minute	1000
Number of hours plant operated during season	2342

Total acre inches pumped, 5100, or 30 inches per acre.
Total cost per acre, $17.73.
Cost per acre foot of water pumped, $7.10.

This customer after only one year's operation with the electric power was so pleased with its cost of operation that he plans to irrigate 360 acres of land in 1916, and is now installing two new electric units, one of 60 h.p., and one of 35 h.p. This 35 h.p. will replace the 25 h.p. in use last season, and he figures on pumping a total of 84 inches per acre.

At White Bluffs, we have in operation three 5 h.p. plants upon adjoining ranches. During the year 1913, these three tracts secured their water from one central pumping plant and the water was delivered to the three farmers upon the rotation plan. Each man took the entire supply for three days which enabled him to get over his tract quickly with the large head of water available, and the operation of the plant represented an excellent load factor, and consequent low costs per acre for power.

The year's results affords interesting information, especially as later on they decided to operate singly, notwithstanding the higher costs of operation by so doing. In 1913 we have the following data upon the entire three tracts of land, which consisted in that year of a total of 77 acres, but as one tract of 25 acres did not come into the plan until early in June, we will call it 70 acres for the season.

Cost of 7½ h.p. motor and pump	$ 400.00
Pump house	100.00
Suction and discharge pipes	800.00
Total investment	$1,300.00

Investment cost per acre, $17.00.

Operating Costs.

Electric power charges, 1913	$ 269.60
Interest 8 per cent on investment	104.00
Depreciation 7 per cent first 2 items	35.00
Depreciation 12 per cent on pipes	100.00
Oil, repairs and attendance	6.00
	$ 514.60

Summary of Costs and Operating Characteristics.

Average height water pumped (feet)	50
Horsepower in-put to motor	8.8
Gallons pumped per minute	350
Number of hours plant operated	2965

Total acre inches pumped, 2297, or 33 inches per acre.
Total cost per acre, $7.35. Cost per acre feet of water, $2.67.
Plant operated on a load factor, 68 per cent.

This arrangement, while very pleasing in its cost per acre, especially as far as the power bill was concerned, was not satisfactory, as the different parties considered themselves deprived of the use of the water when needed badly, consequently the three 5 h.p. outfits were installed and during 1915 we have the following result irrigating a total of 87 acres:

Cost of 3 pumps and motors	$1,038.00
3 pump houses	200.00
Suction and discharge pipes	1,200.00
Total investment	$2,438.00

Investment cost per acre, $28.00.

Operation Costs.

Interest at 8 per cent on total investment	$ 195.04
Depreciation at 7 per cent first two items	86.66
Depreciation at 12 per cent last item	150.00
Combined power bills, 1915	535.95
Oil, repairs and attention	15.00
Total costs	$ 982.65

Summary Operating Costs and Characteristics.

	Tract No. 1 27 acres.	Tract No. 2 35 acres.	Tract No. 3 25 acres.
Average height water pumped (feet)	50	50	50
Gallons per minute	250	250	225
No. hrs. plant operated	1292	1787	2864
Total acre hr. pumped	698	983	1288
Inches per acre	26	28	51.5
Total cost per acre	$11.71	$9.34	$13.15
Cost per acre ft. water	5.40	4.00	3.10
Power cost only, per acre	5.93	5.05	7.95
Load factor of plant (per cent)	30	41	66

It will be seen, therefore, that the plants operating as one unit secured a total of 33 inches of water for 70 acres at a total cost of $7.35 per acre against the individual operations of 35 inches per acre at a total combined cost of $11.30.

It is interesting to note that tract No. 1 and 25 acres of tract No. 2 were piped at a cost of about $500 each to distribute the water with a minimum of loss through evaporation and percolation. Tract No. 3 has little piping and pays $2 per acre more for power for his 51 inches than tract No. 1 did for his 26 inches. Assuming that his crops receive the same amount of water as tract No. 1, his cost will be just $50 greater for power, and we will say that this represents his penalty through evaporation and percolation. Tract No. 1, however, has an investment of $500, which represents a yearly interest charge of $40, in addition to which he has a depreciation of $62.50 or a total of $102.50 to save the same amount of water that the other man paid $50 for. This condition or comparison may be peculiar to these particular parties, and I will leave it with you to draw your own conclusion.

In concluding, I will state that the above named plants are representative ones picked at random from 110 customers with a connected load of over 700 h.p. Together they irrigate a total of 3500 acres and while some of them have a greater cost per acre, and some less, I consider the ones mentioned as a fair average and within the reach of all. In addition to the above, we have in my district eight large plants with a connected load of 2975 h.p. actually irrigating some 14,000 acres of land.

FEASIBILITY OF WESTERN ELECTRO-METALLURGY.

BY DORSEY A. LYON AND ROBERT M. KEENEY.

[Continued.]

Steel. As the manufacture of ferro-alloys developed, and the necessity of producing alloys of low carbon content became apparent, the design of the electric furnace was gradually altered so as to make the operation possible without a conducting carbon lining. It was only a step from the Heroult ferro-chrome furnace lined with chromite with a bottom carbon electrode, over which the metal was permitted to freeze to prevent carburization, to the non-conducting hearth of the modern Heroult steel furnace. The fundamental principles of the modern Heroult furnace were patented in 1900.

In the meantime Stassano of Italy through an interest in the carbide industry had attempted to produce steel directly from iron ore in the electric furnace with charcoal as a reducing agent. The first experiments were conducted in 1898 and were successful technically, but not as commercially because of the high cost. From these experiments on iron ore Stassano turned to the development of his furnace for the manufacture of steel from scrap iron and scrap steel, and he had a furnace operating for this purpose at Turin at the time of the visit of the Canadian Commission in 1904. This furnace was similar to the modern Stassano electric steel furnace.

The application of the induction principle to the manufacture of steel was begun not because of an overdevelopment of any electric furnace industry, but because of actual need of such a furnace in steel manufacture. In 1899 Kjellin, a Swedish electrical engineer, was requested by the works manager at Gysinge, Sweden, to construct an electric furnace. The furnace was to be used for the production of the highest grades of tool steel from Swedish iron. As Kjellin did not approve of the arc furnace because of possibility of contamination by the electrodes, the furnace was based upon the induction principle. In March, 1900, the first steel ingot was cast. In fundamental principles the first furnace was practically the same as the modern Kjellin electric steel furnace.

During the trip of the Canadian Commission of 1904, experiments on the manufacture of steel from scrap steel and iron were made in the Kjellin furnace at Gysinge, Sweden, and the Heroult furnace at La Praz, France. The conclusions reached in 1904 by Harbord, the metallurgist of the commission, in respect to the electric production of steel, were as follows:

1. Steel equal in all respects to the best Sheffield crucible steel can be produced either by the Kjellin or Heroult processes at a cost considerably less than the cost of producing high class crucible steel.

2. Structural steel to compete with Siemens or Bessemer steel can not be economically produced in electric furnaces and such furnaces can be used commercially only for the production of exceptionally high class steel for special purposes.

In connection with the development of the Girod ferro-alloy works at Ugine, France, Girod had devised an arc with a non-carbon-conducting hearth that was used for the manufacture of low-carbon alloys. As the ferro-alloy industry became well established, Girod turned his attention to a steel furnace, and in 1905 constructed a furnace based upon the principles of the earlier ferro-alloy furnace.

After the introduction of the non-carbon-conducting hearth in 1905, other furnaces similar to the Girod were developed. The Keller and Gronwell furnaces both have a non-carbon-conducting hearth. Nathusius built a furnace combining the arc and resistance principles. Other furnaces of the arc type which have been designed and built since 1904 are the Anderson, Chaplet and Soderburg furnaces.

The Rochling-Rodenhauser electric steel furnace was developed from the original Kjellin induction furnace in 1906 to meet the requirements for refining molten basis Bessemer steel. It is the most widely adopted induction furnace of the present time. Other induction furnaces are the Frick, the Hireth and the Paragon furnace of Harden.

Electric copper smelting. Development of the electric smelting of copper ores has been very slow, due to the fact that there has been very little need for much development along this line, considering the low cost of combustion furnace copper smelting in most mining districts. Electric copper smelting would be successful commercially only in mining districts where the ore supply was so located as to make coke very expensive and where electric power could be developed very cheaply. There have been several experimental runs made on electric smelting of sulphide, oxide and native copper ores.

Vattier conducted experiments for the Chilean Government in 1903 at the works of Keller, Leleux & Co., Livet, France. The test was conducted on a commercial scale using a furnace with a capacity of 25 tons of ore per 24 hours, requiring a steady load of about 700 horsepower on the furnace. Sulphide and carbonate ores were smelted. While the run was successful technically, a matte containing 48 per cent copper being produced by careful mixing of the ores, the cost of smelting was found to be high.

Schilowski and Wolkoff have recently conducted small scale experiments on electric smelting of sulphide and oxide ores of copper, but no definite conclusion can be drawn from their work.

Stephan, superintendent of the Girod electric steel works at Ugine, France, reported some experiments of his in 1913, in which Belgian Congo oxide ore of copper was smelted to produce copper bullion in a furnace similar to the Girod ferro-alloy furnace. The experiments were apparently successful for oxide ore. Sulphide ore was not smelted.

In 1913 we conducted a series of experiments for the U. S. Bureau of Mines on the electric smelting of native copper concentrates and sulphide ores of copper. The work was done in a 60 horsepower furnace and considerable data obtained showing what might be expected technically in electric copper smelting and general figures as to cost of smelting. From a technical standpoint it was evident that no greater difficulties would be met with the electric furnace than with the combustion furnace. But commercially it is clear that electric copper smelting can only be used to advantage in place of combustion furnace smelting where coke is very expensive and electric power very cheap.

Electric zinc furnace. The use of the electric furnace in the metallurgy of non-ferrous metals has had

greater application for the treatment of zinc ores than is the metallurgy of any other of the non-ferrous metals except aluminum and ferro-alloy manufacture. Since 1885, when an electric furnace for the treatment of zinc ores was patented by Cowles Bros., experimental work has been conducted on this subject. The commercial application of the process, however, has not resulted to any great extent because of the difficulty of condensing zinc vapor produced under the smelting conditions of the electric furnace. The cause of this difficulty has not yet been definitely determined. With few exceptions the experimental work has not been conducted on a very large scale, and so it may be said that the electric smelting of zinc ores is still in the experimental stage, although it is more advanced than electric smelting of copper ores.

For several years experimental work on a laboratory scale has been conducted at McGill University under the direction of Dr. A. Stansfield and W. R. Ingalls. This experimental work has been largely directed toward a study of the condensation problem and the speed of reduction.

One of the most persistent investigators of the possibility of smelting zinc ores in the electric furnace is W. McA. Johnson of the Johnson Electric Smelting Company. He has conducted experiments on a large laboratory scale for several years. As a result of the success of these experiments, a small commercial plant is now being installed at Keokuk, Iowa.

The experimental work performed with the De-Laval furnace has resulted in the establishment of a large electric smelting plant at Trollhattan, Sweden. Zinc smelting has been conducted at this plant for six or seven years, but part of the product has been the result of refining dross and scrap.

All of the people mentioned above in connection with electric smelting of zinc ores have used an electrode furnace and carbon as a reducing agent. The ore was roasted previous to smelting for removal of sulphur. There have been two exponents of the use of iron as a desulphurizing agent in electric smelting of zinc sulphide, i.e. the Imbert and Cote-Pierron processes. Imbert tried out the reaction without much success in the combustion furnace. Thomson and Fitz-Gerald later designed an electric furnace for its application. After testing the Imbert-Thomson-Fitzgerald process for several years in Upper Silesia, it has apparently proven unsuccessful, as further work is not being done. Resistance furances were used which did not appear to have very high thermal efficiency. In the Cote-Pierron process an electrode furnace is used. The process did not appear successful from the first work done due to condensation difficulties, but it was recently reported that a small plant was being erected in France.

Present Commercial Status of Electrometallurgy.

Aluminum. All aluminum manufactured today is produced by an electrometallurgical proccess, either by the Heroult process or the Hall process, both of which are essentially the same. In the United States the Hall process is used and in Europe the Heroult process.

The production of aluminum in the United States has not increased materially since 1912, but exact figures are difficult to obtain, owing to statistics being given for recent years as consumption. The consumption in 1913 amounted to 72,379,090 lb., of which probably about 30,000,000 lb. was imported during the calendar year. Importations during the year ending June 30, 1913, amounted to 26,642,112 lb., and imports were increasing at the end of that period. The actual production for 1913 in the United States may be roughly estimated at 42,000,000 lb. In 1907 60,000 h.p. was being utilized in the manufacture of aluminum in the United States. Today probably 80,000 h.p. is in use for this purpose.

Up until recently the production of aluminum in the United States was entirely controlled by the Aluminum Company of America, owners of the Hall patents, which have now expired. In this country this company has one plant in operation at Niagara Falls, N. Y., and one at Massena, N. Y., as well as one in Canada at Shawinegan Falls. The company plans the construction of a plant at Marysville, Tennessee, where there is reported to be a possible power development of 100,000 h.p.

On the expiration of the Hall patents in the United States, a company was formed by French financiers interested in the Aluminum Francaise under the name of the Southern Aluminum Company. A plant is in course of construction at Whitney, North Carolina, on the Yadkin River, where a total development in high water of 100,000 h.p. is possible, although the average power will be about 45,000 h.p. The capacity of the plant to be erected will be 20,000,000 lb. of aluminum per annum.

In Europe the aluminum industry has progressed as rapidly as in the United States. From the table below, Europe in 1912 produced about three and one-half times as much aluminum as the United States, but this country leads in individual production, with France second.

*World's Production of Aluminum in Metric Tons (2204 lb.)

	1910	1911	1912
United States	16,100	18,000	18,000
Canada	3,500	2,300	8,300
Germany, Austria-Hungary, Switzerland	8,000	8,000	12,000
France	9,500	10,000	13,000
England	5,000	5,000	7,500
Italy	800	800	800
Norway	900	900	11,500
Total	43,800	45,000	61,100

*As reported by Metallgesellschaft, Frankfurt A. M.

There are five large companies producing aluminum in France in connection with the maufacture of other electrometallurgical or electrochemical products, such as ferro-alloys, electric furnace steel, calcium carbide, chlorates, sodium, potassium and cyanides. As all of these companies manufacture numerous products, it is impossible to segregate the capital invested in each or the power consumed, but practically all of the French aluminum is made by these companies which sell their product through a syndicate called Aluminum Francaise.

It is probable that there will be a large increase in the aluminum production of Norway very shortly, as one English company has recently completed a plant of 2000 tons annual capacity at Vennesla, near Christianssand, and a Norwegian company has almost completed its plant near Arendal at Eydehaven, which when working full will take 25,000 h.p.

(To be continued.)

PRODUCER GAS POWER FROM NORTHWESTERN COALS.

BY H. V. CARPENTER.

(A brief report is here given of the adaptability of Washington coals for more efficient utilization in the gas producer. This paper is taken from the Journal of the Oregon Society of Engineers. The author is professor of mechanical and electrical engineering at Washington State College.—The Editor.)

The production of producer gas is fundamentally a very simple process. Any coal or wood fire which has too small an air supply generates partially burned gas which might be called a poor grade of producer gas. Control of the thickness of the fire and the addition of a little steam greatly improves the gas until it yields about one-quarter as much power as first-class city gas. The easy control, continuous process, and the fact that as high as 90 per cent of the heat of the coal can be delivered in the gas makes this method one that is growing in favor as its uses and behavior become better known. If the gas can be used hot from the producer, as in special furnaces in many manufacturing processes, there is less waste of heat than is common in furnaces fired directly with coal and much better and more convenient furnace control results. Used in gas engines for power the engine draws its own gas supply from the producer, the engine itself is simple in design and its use involves no unusually high pressures or temperatures which are so fatal to long engine life and reliability.

Another interesting characteristic of the gas producer is the fact that it is frequently able to utilize to good advantage fuels which are not of much value for domestic use. In fact, many varieties of coal that are not successful competitors with other kinds for use in large steam plants will give good results in producer work. The lignites which are high in ash and moisture and low in fixed carbon are usually too flashy and break up too much for good service elsewhere but in the producer can generally be handled easily and with good efficiency. Coals which clinker badly will give trouble in the producer, though some coals will clinker in the very hot fires under large steam boilers which will not bother in the producer when properly handled. A non-coking coal requires less poking and is usually used in preference to a coking coal, in part perhaps, because the steam plant will usually pay most for the coking coal.

It is reported than an enterprising Englishman has an automobile driven by its own producer and engine. The engineers in this country have been quite conservative in the sizes and types which they have attempted to build, limiting them to sizes of 50 h.p. and over. This seems to be due more to the fact that the producer gas equipment requires competent attendance than to any very great difficulty in making smaller units run successfully. The saving in attendance will usually make the gasoline engine most economical in sizes where the fuel consumption is not of vital importance. One of the peculiar properties of all gas engines as compared with steam engines is their comparatively high efficiencies in small sizes. This leaves the best field for the producer plant in the middle sizes of from 50 h.p. to 1000 h.p. because in very large sizes the modern steam turbine has no competitor when first cost and over all efficiency are considered. In this middle field the producer engine can give very good service. Especially when near a cheap supply of suitable coal and when steady and long-continued loads are to be carried. The producer gives very little difficulty in starting and stopping and the standby losses are small since the fire pot is so built that the fuel can be made to hold the fire a very long time. Steady loads are, however, necessary, if good showings for economy are to be made, because the first cost of the producer equipment including all auxiliaries is quite high, so that it cannot be used for loads that are to be carried only a short time during the year.

For the past five years a series of tests have been carried out at the State College of Washington mainly for the purpose of determining the adaptability of the many kinds of coal in the Northwest for producer practice. The principal value of the tests have been in showing that most of the different fields produce coal that will behave well in the producer. If a coal handles easily and is cheaper than any other of similar heating value it is quite likely to prove the most economical for use, so we have not laid great stress on exact determinations of efficiency although many such tests have been made. The tests indicate that general statements may quite safely be made as to the adaptability of the coals from different districts without specifying any particular mine. Repeated attempts to use coal from the Roslyn field have all failed to give good results mainly because of clinkers and trouble in keeping the fuel bed uniform enough to give good gas.

Coal from the Mendota and Carbonado districts of western Washington have been tested many times and always without trouble. The Mendota coal carries more moisture than any other tested and so required less steam to make good gas.

Several tests have been made on the coals from Wyoming which are common in eastern Washington markets. All of these have given good results and practically no trouble in handling.

Only one Canadian coal, the "Hill Crest," has been tried. This is a coal with much higher fixed carbon than the successful Washington coals but gave fairly good results even though the coal used would be classed as screenings. This coal in pea size or larger would give good results.

The results may apparently be summed up by saying that any of the free-burning western coals which do not clinker in ordinary firing will work well in the gas producer. The amount of coal used in these tests has varied from 1.78 lbs. to 2.6 lbs. per h.p. per hour which would indicate very satisfactory results in larger plants. The producer used was a Smith down draft type, with automatic steam control and mechanical scrubber. Little trouble has been had with tar reaching the engine, and with a good coal the quality of the gas has not been hard to maintain. More trouble has been experienced with the ordinary mechanical difficulties with the engine and auxiliaries than with the producer. It should be said that when the troubles common to any gas engine and the

peculiar characteristics of the producer are considered it is probably necessary to supply a little better grade of attendance than would be needed for a steam plant of the same size. This difference is not great, however, for we have trained several men to handle the plant with no very great trouble. These results prove that there are many conditions and localities, particularly in western Washington and Oregon, where the producer plant will prove to be entirely satisfactory both in economy and reliability.

UNDERGROUND CABLE SPLICING.

BY JAMES BURNS.

(This brief account of approved practice is taken from the bulletin of the Pacific Light & Power Company of Los Angeles, with which company the author is connected in the underground cable department.—The Editor)

Ten years ago practically all of our underground cables were rubber covered, taped and jute braided. Today almost 75 per cent of this cable has been replaced with paper insulated lead sheath cables. We have standardized on this class of cable.

The rubber covered cables were spliced by stripping 1½ in. of rubber from the end of each cable, then removing one inch of the outside braid and tape so that when insulating the joint the rubber wrapping tape would vulcanize with the black rubber insulation of the cable. The conductors were connected with a 3-inch copper sleeve, tinned and sweated on the conductor, then insulated with rubber wrapping tape according to the operating voltage of the cable, a binding of friction tape and a double layer of P. & B. tape finishing the splice. In the old redwood duct section of our underground system it was very difficult to make these joints so as to be thoroughly electrically insulated.

In connection with the paper insulated, lead covered cables, there are many different kinds and sizes of splices, depending on the voltage of the cable and the size of the conductor. The most common splices in our system are made on single conductor, duplex conductor and three conductor cables. Under ordinary circumstances prepared paper tube insulators are used. The tube is built up of laminations or layers of paper, spirally wound, forming a tube, the insulating being equivalent to the insulation of the cable on which it is used. It is then impregnated with a moisture proof compound and sealed with paraffine. In preparing for the splice seven inches of lead sheath is stripped from the end of one cable, four inches of lead sheath is stripped from the end of the other cable. One of these paper tubes is slipped over each conductor of one of the cables. A 12-inch lead sleeve having a diameter of about two times the diameter of the cable is slipped over the sheath of the other cable. The conductor is spliced with a copper sleeve 2½ in. long, slipped over the ends of the conductor of both cables and carefully soldered. The paper insulating tubes are then slipped back over the copper sleeve and tied with linen tape. The lead sleeve is then slipped over the entire splice, both ends dressed down to the outside diameter of the cable and a joint is wiped, soldering this lead sleeve to the sheath of each of the cables. The wiping of this joint is one of the most particular operations of the splice. In some instances the splicer juggles, in the operation, as much as 12 pounds of molten solder on a wrapping cloth of 6 or 8 in square. When the solder has cooled a fill hole and a vent hole is cut in the lead sleeve. The sleeve is then filled with a boiling insulating compound. We use, for this operation, a compound known as "Ozite." This compound thoroughly fills the sleeve, preventing the possibility of moisture entering the cable in the event of a pin hole either in the wiped joint or the lead sleeve itself. In many instances conditions are such that the paper insulating sleeve cannot be used and in its place there is substituted tape insulation, which is wrapped on the splice spirally. In this operation extreme care must be exercised, and it requires about three times the labor and time to make such a splice.

To splice single conductor cables the operation is practically the same, but due to the fact that we have only one conductor to work with, the operation is much simpler and the lead sleeve itself considerably shorter. In many instances splices must be made on all classes of cable without interrupting service, and jumpers are used to conduct the current around the splice and the splice is made with the full potential on the conductor at all times. Such a splice on a 2400 volt primary cable is a common occurrence, the splicer using rubber gloves and other protective devices to insulate himself from the ground and from the other conductors.

The 15,000 volt splice is made by removing 10 in. of lead armor from one of the cables and 6 in. of lead armor from the other. The outer binder or belt of the paper insulation is removed within two inches of the armor. It is square and left for a heel. The conductors are separated and paper insulating tubes are placed over each conductor of one of the cables. A 3½ in. paper tube is placed over the conductors of the other cable. The operation of splicing the conductors with copper sleeves is performed and a single layer of empire cloth tape is wrapped over the copper sleeve, the tubes slipped back over the splice and tied in place with linen tape, the large tube slipped back over the entire splice and securely bound with linen tape. A 6 in. lead sleeve 20 in. long is split and placed over the splice, dressed down to fit the cable wiped to lead sheath of each cable and the filling operation is performed.

The latest splice which we have been called upon to make is an insulated joint placed in the lead sheath, sectionalizing various districts and breaking up the flow of stray currents in the armor of the cable. This is made by cutting out 1 in. of the lead armor of the cable, taping the same with insulating tape. Over this is placed a 3-in. fibre sleeve 4 in. long, which has been tongued and grooved to a perfect fit. A split lead sleeve is dressed down to fit this fibre sleeve and wiped to each cable. Two iron bands are clamped around the lead sleeve and 1½ in. of the sleeve is cut away. The entire sleeve is then filled with insulating compound.

In my opinion splices such as I have described are electrically the best insulated part of the cable. In all of our cable failures not over one or two can be traced directly to the splice, and in these instances negligence was probably the cause of the failure.

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The Cash Value of Engineering Research

Considerable criticism has always been made regarding the comparative neglect of means for promoting industrial and engineering research in America. Germany's great industrial advances were largely due to government aid and encouragement in this direction. Consequently it is of interest to learn that a bill has been introduced in Congress by Senator Newlands of Nevada providing for the establishment of engineering experiment stations in the several land grant colleges. In general the bill is intended to promote the purposes as outlined in an editorial in these columns some months ago, the specific aims being detailed as follows:

To conduct original researches, to verify experiments and to compile data in engineering and in the other branches of the mechanic arts as applied to the interests of the people of the United States, and particularly of such are are engaged in the industries; also to conduct researches, investigations and experiments in connection with the production, transportation, extraction and manufacture of substances utilized in the application of engineering and of other branches of the mechanic arts to industrial pursuits; water supplies as to potability and economic distribution; sewage purification and its ultimate inoffensive disposal; economic disposal of urban and manufacturing wastes; flood protection; architecture; road building; engineering problems connected with transportation, manufacturing and public utilities; and such other researches or experiments bearing directly on the various industries and occupations of the people of the United States as may in each case be deemed advisable, having due regard to the varying conditions, resources and needs of the people of the respective states and territories.

The sum of fifteen thousand dollars is provided for the prosecution of the study in each college, the general supervision of work resting with the Secretary of the Interior. Bulletins are to be published at least semi-annually detailing results accomplished.

Heretofore there has been too little appreciation of the necessity for co-ordinating science and industry on national lines. The layman is just awakening to the tremendous importance of applied science in warfare but does not yet seem to realize that in the industrial and commercial struggle that will inevitably succeed the war science will play an equally important part.

Money appropriated for research purposes has proven to be one of the soundest forms of national investment. The cash value of scientific research is cumulative and yet science has usually been denied the common privilege of all commercial pursuits,—participation in profits. It is an elementary rule of business that part of the profit shall flow back into the business to be devoted to the production of future output. While science has given incalculable sums of money to the world it is left to maintain itself on little or nothing. Not one-millionth of all the wealth which Faraday poured into the lap of the world has ever been returned to science for the furtherance of its aims and achievements, for the continuance of research.

The supply and training of competent research workers can only be secured through the system of public education. The English National Board of Education has recently approved a plan for the administration of government grants for scientific research and the example should be followed by the United States.

Eliminating the "Electrical" Architect

Whatever action is taken to secure a more uniformly higher standard of electrical equipment in buildings is commendable, but for many years so much has been essayed sectionally along this line that the time has now arrived when collective effort is seen to be essential for the complete success of the plan.

Various factors are involved, the most important of which are the determination of standards, the assurance of their acceptance, together with an insistence upon work being carried out in accordance with the standards thus set.

Pacific Coast associations of electrical contractors and dealers affirm truly that the success of their plans along this line hinge largely upon securing the fullest possible co-operation of architects, but it is equally true that the owners of prospective buildings must be influenced into acceptance of high standards and it will be found that the architect must be compelled to surrender the determination of the electrical requirements of buildings to electrical experts.

The only satisfactory co-operation that can obtain will be between the architect and his electrical engineer for the drawing of electrical equipment specifications of buildings is just as much the work of an engineer as for those covering steel construction, heating and ventilation and plumbing. But to get this fact universally and rapidly recognized will take more than an occasional lecture before architectural societies and the distribution of typical modern electrical specifications to individual architects. That plan has proven inadequate in the past. Just as none but a qualified architect would be permitted to plan any noteworthy edifice so this situation too calls for the recognition of the electrical engineer.

Sectional effort is commendable as far as it goes, but the need now calls for real co-operative effort by a joint committee of electrical and architectural interests.

Legislation has been enacted which prevents the quack doctor from preying upon the unsuspecting. What is admittedly wrong in other spheres of action cannot be justified in the electrical. The electrical equipment of buildings must be made safe, suitable, and satisfactory.

The electrical engineer, in co-operation with others interested, should rise to the occasion and urge upon administrative bodies the importance of his profession in this particular. If it is not permissible or ethical for him to prepare building plans and specifications so likewise it should be made impossible for the architect to invest himself with authority to bungle the work which rightly belongs to the electrical engineer.

Since educational measures have failed, more radical means must be adopted that the "electrical" architect shall exist only as an undesirable memory of the past.

The Mutuality of Confidence

That a successful business can be built only upon a firm foundation of confidence seems so self-evident as to require no demonstration. The transaction of all business requires that men trust each other. Credit depends absolutely upon confidence.

While in this narrow sense the importance of confidence is well recognized in its broader meaning of mutual faith it is sometimes overlooked. To inspire trust in others a man should place his faith in others. People do not believe in him who does not believe in them. While a public service corporation, for example, is jealous of maintaining the confidence of business men it is sometimes careless in retaining the confidence of its consumers.

Confidence begets confidence. So in spite of criticism, notwithstanding the imputation of false motives, it behooves the management of public utilities to hold to that fine faith in human nature that in every human being there is a sense of justice and fair-play which can be appealed to by fair treatment and quiet suggestion. Such confidence engenders public respect, that quality that causes others to unquestionably accept one's statements. It comes only as a result of hard, faithful work, for confidence is a plant of slow growth and requires careful cultivation.

Defining an Engineer

Since the publication of an editorial in these columns entitled "What is an Engineer," the Carnegie Foundation for the Advancement of Science has requested various engineers throughout the country to express their opinion of its summation of those qualities which constitute an engineer. It will be remembered that these included character, judgment, efficiency, understanding of men and technical ability, each qualification being given a percentage rating.

As, on this basis, it would be theoretically possible for a man with no knowledge of the fundamentals of engineering science and having no technique of practice and of business to have a rating of 87 per cent, the suggestion has been made by a number of engineers that any such weighted rating of the relative importance of these several constituents of success is misleading. Each element is essential to that composite man known as an engineer, just as fuel, oil, water, furnace, tubes and stock are necessary to give a boiler. It is like the fable of the quarrel among the several parts of a clock—each is indispensable to its operation. Without any one of them the clock will not go.

The value of an engineer, then, depends upon the degree to which he possesses all these essentials. Lack of any one of them, or even a marked deficiency, would disbar a man from the category. This suggestion seems to be more nearly in accord with actual estimates of an engineer's ability and should be considered in the final definition formulated.

PERSONALS

E. L. Dixon, manager of the Mohrlite Company, will visit the Pacific Coast early in April.

John P. Bell, Pacific Coast manager Standard Underground Cable Company, is at Los Angeles.

A. J. Meyers, Pacific Coast manager of the Wagner Electric Manufacturing Company, is at St. Louis.

E. D. Farrow, commercial agent of the San Joaquin Light & Power Company, is at San Francisco.

W. S. Berry, sales manager of the Western Electric Company at San Francisco has returned from Honolulu.

G. P. Lundie of the Tonopah Tire & Electric Company of Tonopah, Nevada, is here on a short business trip.

W. Brewster Hall, Pacific Coast manager Pass & Seymour, has returned to San Francisco from Solway, N. Y.

C. O. Poole, chief engineer Southern Sierras Power Company of Riverside, Cal., was at San Francisco last week.

Jos. Thieben, general manager, Panama Lamp Company, has returned from an extended business trip in the East.

C. F. Fairly has been appointed Northwest representative of the Kellogg Switchboard & Supply Company with offices in Portland.

E. W. Davies, Pacific Coast agent for the Usona Mfg. Co. Kwik-lite products, has returned to San Francisco from a short trip in the south.

H. A. Lardner, vice-president of the J. G. White Engineering Corporation, recently returned to San Francisco from an extended trip in the East.

Geo. R. Murphy, soliciting agent of the Electric Storage Battery Company of Philadelphia, is making a business trip throughout the Northwest.

H. J. White of the Keeler, White Company, electric manufacturers' agents on the Pacific Coast is making a business trip throughout the south.

E. B. Walthall, assistant general manager of the San Joaquin Light & Power Company, of Fresno, California, spent a few days last week at San Francisco.

John E. Kelly, motor department of the Sheldon Electric Company of New York, in company with **Allyn T. Doty** of the same company, are at San Francisco.

W. P. Naser, manager Trumbull Electric Manufacturing Company, San Francisco, has returned to San Francisco from the Oregon and Northern California territory.

T. E. Nivison has been made manager of the Portland office of the Federal Telegraph Company, succeeding **R. D. Gould,** who returns to his home in Denver.

R. F. Oakes, president of the American Ever Ready Company, of the National Carbon Company, recently left San Francisco for a three weeks' business trip in the East.

K. Mamamoto, engineer of the Nippon Oil Company, Ltd., Tokyo, Japan, in company with **D. Matsuzawa** engineer, and **K. Ito,** secretary of the same company, are at San Francisco.

J. D. Scott, formerly power salesman with the Portland Railway, Light & Power Company, has been appointed assistant engineer in the office of **O. B. Coldwell,** general superintendent of the company.

W. W. Lowe, president of the Electric Appliance Company of Chicago, who has been on the Pacific Coast for the past two weeks, returned to Chicago via Los Angeles, Dallas and New Orleans.

A. T. Menzel has resigned from the engineering department of the General Electric Company at San Francisco to become superintendent of the power plant at Big Bend, with the Great Western Power Company.

Walter C. Clark, electrical engineer Bunker Hill & Sullivan Mining & Concentrating Company, read a paper on electricity as applied at their properties before the Northwest Mining Convention at Spokane, March 21.

Wm. T. Wallace, author of the article on Irrigation Pumping in Idaho, which appears in the March 18th and 25th issues of this journal, is vice-president and general manager of the Electric Investment Company, of Boise, Idaho.

Miss Eugenia Galvin, electric range expert, has returned to San Francisco, after spending eight days in Mountain View, Calif., where she sold twenty Westinghouse automatic electric ranges and as many electric water heaters.

M. L. Joslyn, president of the Baker-Joslyn Company of San Francisco and also president of the Joslyn Manufacturing & Supply Company of Chicago, who has been visiting the Coast for the past few weeks, has recently left for Chicago via Los Angeles.

F. H. Murphy, illuminating engineer Portland Railway, Light & Power Company of Portland; **F. H. Osborn,** professor of physics, University of Washington, Seattle, and **Alexander Macbeth,** vice-president and general manager Southern California Gas Company, Los Angeles, have been transferred to the grade of member of the Illuminating Engineering Society.

N. G. Warth has been appointed general manager of the Interstate Utilities Company, operating telephone properties in Northern Idaho, vice **J. H. Morgan,** resigned. Previous to accepting this position Mr. Warth was connected with the Central Union Telephone Company and more recently was division manager of the American Telephone & Telegraph Company at Columbus, Ohio.

James B. Olson, recently appointed general sales manager of the Habirshaw Electric Cable Company, Inc., of New York, formed by the consolidation of the Habirshaw Wire Company, the Electric Cable Company and the Waterbury Company, has been well known in the electrical wire and cable business for many years. He entered this field as a young man with the New York Insulated Wire Company, later connecting himself with the Habirshaw Wire Company and acting as salesmanager for the past eighteen years.

COMMITTEE ON ELECTRICAL SAFETY RULES.

The California Industrial Commission has appointed a committee to consider tentative rules of the U. S. Bureau of Standards with a view to formulating rules to govern electrical installations in California. Following is the personnel of the committee: Chairman, S. J. Lisberger, engineer of electrical distribution, Pacific Gas & Electric Company, representing the National Electric Light Association, San Francisco section; vice-chairman, J. M. Barry, chief of department of electricity, city of San Francisco; F. Emerson Hoar, gas and electrical engineer, State Railroad Commission; John Hood, General Electric Company; Carl E. Hardy, superintendent of electrical department, city of Oakland; H. C. Reid, Pacific Fire Extinguisher Company, representing the California Association of Electrical Contractors and Dealers; J. Mergenthaler, representing Pacific District Council, International Brotherhood of Electrical Workers; H. M. Hansen, business agent of local union, No. 404, International Brotherhood of Electrical Workers; Arthur Elken, representing local union, No. 6, International Brotherhood of Electrical Workers; W. H. Urmy, representing local union, No. 6, International Brotherhood of Electrical Workers; George Sorenson, secretary of local union, No. 537, International Brotherhood of Electrical Workers; Max A. Schmidt, superintendent of electrical equipment, Schmidt Lithograph Company, representing the California Employers' Federation; Robert L. Eltringham, electrical engineer, Industrial Accident Commission of California; secretary, John R. Brownell, superintendent of safety, Industrial Accident Commission of California.

MEETING NOTICES.

Los Angeles Section American Society of Mechanical Engineers.

At the March 28th meeting W. H. Clapp will give a talk on motor trucks in Southern California. The section holds a lunch meeting every Thursday at the Hotel Hayward Cafe, Sixth and Spring streets at 12 noon.

Oregon Society of Engineers.

The regular monthly meeting was held in the grill room of the Oregon building, Portland, Oregon, March 20th. W. S. Turner, president, presided at the informal smoke during which a free lunch was served. In the course of the evening John Lyle Harrington, consulting engineer, in charge of design and construction of the Columbia River bridge gave a talk illustrated by plans, photographs and lantern slides of the bridge.

California Association of Electrical Contractors and Dealers.

A quarterly meeting of the California Association of Electrical Contractors & Dealers will convene April 6th at the Hotel Oakland, Oakland, Cal., 1:30 p. m. A meeting of the executive committee will be held 10:00 a. m., April 6th, at the offices of the Alameda county section of the association. The regular monthly meeting and dinner of the association will be held Thursday evening, April 6th, 7 o'clock, Hotel Oakland, corner of Thirteen and Harrison streets. All members of the association, jobbers and their salesmen and central station representatives are requested to attend this meeting.

San Francisco Electrical Development and Jovian League.

A pleasing innovation was introduced by Chairman Alvord at the March 22nd luncheon in the form of a mutual introduction plan prior to turning the meeting over to A. E. Drendell, chairman of the day. Mr. Drendell had provided attractive vocal talent in the person of Miss Addie Johnson, who sang sweetly until the introduction of the speaker of the day, Guy L. Bayley, chief electric and mechanical engineer for the Panama-Pacific International Exposition. In an easy, off-hand, Mr. Bayley told of progress and experience in dismantling the exposition. He stated that the salvage of electrical materials represented close to half the cash value of all material yet sold. He also cited a number of interesting and amusing incidents which arose in the course of the exposition period. Just before giving a vote of thanks to the speaker a drawing for a door prize was held, Mr. C. E. Heise being the winner of a new hat.

Los Angeles Jovian Electric League.

S. H. Head, district manager of the Krogh Pump Company, was chairman of the day at the March 22nd meeting. After President Holland had disposed of business matters, the "cares that infest the day" were disseminated by enchanting music and sweet songs. T. Harvey Dukelow, claim agent of the Southern California Edison Company, speaker of the day, gave a half-hour talk on the workman's compensation and insurance law, which became effective in this state January 1, 1914. The theme of his address was "Safe and Sound," and as claim agent of a large corporation, he spoke authoritatively and with practical knowledge of and familiarity with the subject in hand. He spoke of the attitude of the employer towards the law, which he considers is based on sound and sensible principles, and told what the employer is doing along the line of "Safety First," as follows:

"The human element is difficult to analyze and control. There will always be unavoidable accidents and casualties that result from the violation of the law of safety—this by the employer as well as the employee. Determined efforts should be made, and are being made, to reduce the number of accidents to the minimum. When we come to consider the inculcation of habits of caution as a means of accident prevention, we reach the most difficult and at the same time the most important part of the problem. Safeguards, sanitation, safety lectures, etc., can accomplish much, but any accident-prevention movement must fail largely of its purpose, unless the co-operation of the workmen, themselves, is secured.

"The companies are now fully awake to the significance of education as a prevention of accidents. Technical skill is desirable, but so, also is education that will develop mental alertness, accuracy of judgment and a genuine and lively interest in the company. Education is imperative for bringing the workmen to a clearer appreciation of life and its responsibilities, and making him more alert to the opportunities and dangers of his profession. But the man who has been at a trade for years is set in his ways and intolerant of change, and unfortunately, this has its bearing on others. Thus, we turn more to the younger man—the new hand at the business—and endeavor to produce workmen who not only will tolerate safeguards and use them, but who from force of habit, will be addicted to safe habits of working.

"Machinery of today exacts from the workman his continual attention, as well as keen and sure ability. This calls into play all his faculties, and it is necessary that he should enter upon the work with a clear mind, and a mastery of himself that he can never have, if addicted to the use of strong liquors, or laboring under some mental strain—quite frequently domestic trouble.

"This brings me to what I believe to be the point of departure in education—the foreman. By friendly personal contact, the foreman is in a position to know the mental and physical condition of the men under him, and in handling such a dangerous agency as electricity, it is obvious that a change of employee is essential where an employee handling dangerous work—is laboring under such great difficulties.

"The employer of today is providing sanitation and education, and this from a humanitarian as well as an economical viewpoint, in the hope that some time, somehow, a careless act will be averted with the result that the employee involved may go home to his family "safe and sound" on the pay-day following."

His talk received loud applause and was enjoyed by all present. Announcement was made that President Henry F. Holland had been appointed honorary member of the Los Angeles Realty Board, after which the meeting adjourned. Ross B. Mateer, commercial agent for the Southern Sierras Power Company, at Riverside, California, will have charge of the April 5th meeting, and is planning some big things. It is expected that a large delegation of visitors from Riverside will be present.

CELEBRATION BY NEVADA ENGINEERING STUDENTS.

The annual engineers' day celebration at the University of Nevada on March 20th was featured by a spectacular parade through the streets of Reno and brought to a close by a unique dance in the university gymnasium. Students from several engineering colleges had prepared typical exhibits in the gymnasium. The electrical engineers ran a generator, operated wireless telephone and telegraph instruments and made demonstrations of high potential electricity. Through the courtesy of the Reno Power, Light & Water Co., several unique lighting effects were obtained. Several moonlight dances transformed the gym into a veritable fairyland, with a moon in the shape of a monster flood-light, filtering down through the canopied roof. This light was one of several used at the Panama-Pacific exposition. In a darkened booth just off the main dance floor, Prof. Hartman presided over a demonstration of high potential discharges through various gases. The beautiful colors resulting and the startling effects obtained, aided greatly in the general enjoyment. An electric waterfall, operated by centrifugal pumps and showing varicolored lights, was another feature in connection with a surveyors' camp established by the civil engineers. The miners operated a miniature crushing and concentrating plant. The mechanical engineers exhibited a model steam locomotive.

TRADE NOTES.

The Hall-Scott Motor Company of Oakland, Cal., have increased their output from four to six motors each week, or a motor a day.

The Mohrlite Company, manufacturers of indirect lighting fixtures, have moved from 247 Minna street to 641 Mission street, San Francisco.

The Wagner Electric Manufacturing Company have started construction on two new buildings to augment their present factory group on Plymouth avenue, St. Louis.

The Bradshaw Electric Sign Company of Oakland, Cal., reports orders from Taft, Madera, Bakersfield, Oxford, Santa Maria, Santa Clara and Martinez. These signs were all of steel with flash electric effects.

The San Francisco Commercial Club will celebrate "Ten Years After" in a great gathering at the Exposition Auditorium, April 18, 1916. This will celebrate the upbuilding of the city during the past ten years.

The Hawaiian Electric Company, Ltd., have recently placed a very large order for equipment for a large substation which they have found necessary to erect to supply the growing demand for electricity on the island.

The Great Western Power Company recently gave a contract to the Associated Engineering & Supply Company of San Francisco for six automatic master oil controllers, an automatic device for eliminating unnecessary losses in burning fuel oil.

Westinghouse Electric & Manufacturing Company, Portland, have orders for supplying Crown-Willamette Paper Company, Oregon City, with an 1800 h.p. synchronous motor for driving four 4-pocket grinders; two 22,000 k.v.a. 60,000-volt transformers, and a 9-panel switchboard, for the new paper mills under construction there.

Oakland Milling Company, Oakland, Cal., will erect an electrically driven rice mill, elevator and warehouse on Oakland Estuary, near Park street bridge, Oakland. C. F. Adams and D. J. Hayes are acting as engineers. The mill will have a capacity of 3000 sacks of rice of 100 lb. per day and will be equipped to make cattle food, bran and hulled material as well as rice flour, etc.

The S. & N. Electric Company, formed in the early part of 1915 for the purpose of transforming gas, gasoline and blueflame stoves to electric has changed its name to the N. & N. Electric Company, with headquarters at the Electric Shop, 237 Powell street and 1612 Haight street, San Francisco, Cal. T. H. Nelmes, president of the company, states that they will also manufacture a projector for the lighting of pictures which does away with the defacing reflector or hood, and which lights the picture and frame only.

Mr. Arthur Simon, of the engineering department of The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., gave a lecture on magnetic solenoid apparatus before the Engineering Society of Milwaukee, February 16th. During his discussion he showed numerous charts, giving characteristics of solenoids of various kinds, a. c. and d. c. The effect of "coneing and plunger" was also discussed, as well as other peculiarities in design and construction. To further illustrate the lecture, Mr. Simon had a number of the Cutler-Hammer solenoid brakes, contractor type switches and a C-H magnetic gear shift. This device is the apparatus which this company is now furnishing for use on automobile gasoline motor cars and which makes it possible to shift gears from a push button station located just at the fingers' tips below the steering wheel. In the design of this apparatus it was shown how the initial pull brought about by the solenoid method is strong and then as the stroke is about completed how the pull is shaded off. Mr. Simon also showed how the amount of current required for this device is now only a fraction of what was required with early types of this device. This is due to the proper designing of the solenoids and the working parts at the present time. The amount of current to operate this device is less than for a single blast of the electric horn. The starting and lighting systems of the standard motor car can, of course, be used with this gear shift. The lecture was concluded by showing a 1000 foot "movie" reel featuring two of the Cutler-Hammer high duty lifting magnets at work in the plant of the Inland Steel Company, Indiana Harbor, Ind. The handling of the huge masses of scrap, pig iron and other material, as well as the lifting and dropping of the 20,000 pound skull cracker ball proved to make a very animated and interesting "movie."

NEW CATALOGUES.

Electrical Theatrical Devices of all kinds are illustrated and described in Bulletin No. 49200 from the Sprague Electric Works of the General Electric Company.

Catalogue 28 from Thomas Day Company, San Francisco, is a handsome volume, 10 by 14 in., illustrating their latest designs in electric lighting fixtures. It gives dimensions and prices of fixtures and also shows glassware.

Mica Insulator Company of New York City have issued descriptive bulletins on "Conducell," a method of insulating cable joints in underground transmission systems and "Conduline," a compound for filling the joints of cables.

Incandescent Supply Company of San Francisco have issued a large catalogue of the complete line carried in local stock. This includes not only various electrical specialties but an illustrated description of gas and electric fixtures, including globes and reflectors.

Bulletin No. 46023, recently issued by the General Electric Company, describes briefly that company's arc circuit volt meter, a special instrument designed for testing direct current series arc circuits. The approximate dimensions and the connections together with prices are included.

NEWS OF ARIZONA CORPORATION COMMISSION.

Arizona, California & Nevada Telephone Company has been authorized by the commission to purchase the telephone lines and exchanges in Mohave county owned by Dan Angius, for $2000.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

The Fresno Interurban Railway Company has applied to the commission for authority to issue $150,000 of bonds, and $60,000 of stock, to cover cost of construction of its main line to the Centerville Citrus District, and to issue $150,000 of certificates of indebtedness at 6 per cent for not over 15 years.

The Western States Gas & Electric Company has applied to the commission a supplemental application for approval of expenditures of $9,714.47 for additions and betterments to plant.

The commission has issued an order authorizing the Valley Telephone Company, operating in Imperial county, to issue 206 shares of stock of the par value of $100 each, a promissory note for $1500 at ten per cent to renew a similar note, and another promissory note for $1000 at ten per cent to renew a note.

NEWS OF IDAHO PUBLIC SERVICE COMMISSION.

Upon the complaint of the Village of Roberts, Jefferson county, that the Ashton and St. Anthony Power Company was not prepared to comply with the provisions of its certificate of public convenience and necessity as regards Roberts until 1917, the commission has ordered that the certificate be set aside only in so far as it affects the Village of Roberts and vicinity. The Utah Power & Light Company, as an intervener, has been given permission to extend its transmission lines and construct such distribution systems as necessary to serve the district. A further hearing as regards the ability of the Ashton & St. Anthony Power Company to serve irriga-

tion consumers in the vicinity of Mud Lake will be held August 1, 1916. About 5000 acres of land in the vicinity of Roberts require irrigation for successful farming, while about 80,000 acres are without water near Mud Lake, including the irrigation projects of the Owsley-Carey Land & Irrigation Company, Mud Lake Canal Company, North Lake Land Company and Crystal Lake Irrigated Lands Company. The Ashton & St. Anthony Power Company is building a dam and power house on the North Fork of the Snake River, two miles from Ashton and fifty miles northeast of Mud Lake. The plant will have a capacity of 5000 h.p. and cost about $325,000. The Utah Power & Light Company is already serving Menan, seven miles west of Roberts.

BOOKS REVIEWED.

"Electric Railway Engineering," by C. F. Harding and D. E. Ewing; 409 pp.; 6x9 in. Published by McGraw-Hill Book Co., New York, and for sale by Technical Book Shop, San Francisco. Price $3.00.

This is the second edition of a text which has already proven valuable in the study of the engineering and economic problems encountered in electric traction. It has been completely rewritten in accordance with the dictates of recent practice. The book is divided into four parts, treating respectively of the principles of train operation, power generation and distribution, equipment and types of systems. While written primarily for engineering students, it will be found useful by all practicing electric railway engineers.

"Coal and Coke," by F. H. Wagner; 429 pp.; 6x9 in.; illustrated. Published by McGraw-Hill Book Co., and for sale by Technical Book Shop, San Francisco. Price, $4.00.

Information on the carbonization of coal incident to the manufacture of coal gas is herein concisely and logically presented. After treating of the origin and classification of coal, due consideration is given to the theory and practice of its oxidation and spontaneous combustion. Then is considered the distillation of coal, its analysis and its preparation and storage. Succeeding chapters are concerned with carbonization in retort benches, combustion and heating of settings, flue gases, thermic reactions, carbonization in ovens, low temperature carbonization from production with waste heat and the characteristics of coke. The historical method is followed throughout, with special attention to recent methods.

"Central Station Management," by H. C. Cushing, Jr., and Newton Harrison, 397 pp., 5 by 7½ in. Published by D. Van Nostrand Company, New York, and for sale by Technical Book Shop, San Francisco. Price $2.00.

Examination of this text would seem to indicate that the subject of rates is the point about which the entire central station business operates. In fact "electric rates and costs" might well be the title of the book, as fifteen of the thirty-two chapters are devoted to the subject. Other topics discussed in detail are methods of getting new business, illumination and boiler management. The discussions are mostly "editorial" in character and present a general survey of central station problems aside from those of public policy. It would be an excellent text to place in the hands of every public service commissioner or other person having to do with rate regulation. It also brings into compact form many diverse subjects of plant management. The addition of an index would greatly facilitate the use of the material here compiled.

"Pole and Tower Lines," for Electric Power Transmission. By R. D. Coombs; 272 pp.; 6x9 in. Published by McGraw-Hill Book Co., and for sale by Technical Book Shop, San Francisco. Price $2.50.

This text comes within the category of engineering literature defined by Prof. Fish as dealing with engineering economics, or, more specifically, economic selection. The author is confessedly a civil engineer, incidentally a most capable one, and apparently somewhat jealous of the tendency of electrical engineers to determine structural details. The book deals, not with "purely electrical problems, such as the relation of voltage and size of the wires to the electrical characteristics of a line," but the application of the laws of mechanics to line construction. After a preliminary discussion of various types of construction, detailed consideration is given to general design with particular reference to wooden, steel and concrete poles and towers. Foundations, protective coatings, line material and protection are the subjects of separate chapters. The treatment of erection methods and costs is rather limited, but sixteen pages being devoted specifically to the subject. The last chapter contains general specifications for lines, crossings and galvanizing. The subject is handled from the standpoint of a broad survey, rather than specific cases and is concerned with principles rather than applications. An excellent basis for comparison and choice of various types is afforded by the author's well-substantiated opinions. The book covers a field about which there has been a dearth of published information and deserves a place in the library of any engineer engaged in the construction of transmission and distribution lines.

PUBLICATIONS RECEIVED.

Bulletin 86, U. S. Bureau of Mines, "Some Engineering Problems of the Panama Canal in Their Relation to Geology and Topography," by Donald F. M. Donald.

O. G. Aichel, civil engineer at Portland, Ore., through Spon & Chamberlain of New York, has published a pamphlet on "The Caisson as a New Element in Concrete Dam Construction," a proposal made in connection with the Columbia River Power Project.

"High Vacuum, Hot Cathode Apparatus," by August Hund; Vol. X, No. 6, Bulletin University of Southern California, Los Angeles, a brief technical description of the kenotron and pleioton and their application in electrical engineering.

The U. S. Bureau of Standards has just issued a number of new publications as follows: Circular No. 16, The Testing of Hydrometers; Circular No. 57, U. S. Standard Tables for Petroleum Oils; Scientific Paper No. 262, Present Status of the Determination of the Constant of Total Radiation From a Black Body, by W. W. Coblentz; Scientific Paper No. 266, Preparation of Pure Iron and Iron-Carbon Alloys, by J. R. Cain, E. Schramm, H. E. Cleaves; Scientific Paper No. 267, Calorimetric Determination of Acetylene and its Application to the Determination of Water, by E. R. Weaver; Technologic Paper No. 54, Special Studies in Electrolysis Mitigation; III—A Report on Conditions in Springfield, Ohio, with Insulated Feeder System Installed, by Burton McCollum, Geo. H. Ahlborn; Technologic Paper No. 55, Special Studies in Electrolysis Mitigation; IV—A Preliminary Report on Electrolysis Mitigation in Elyria, Ohio, with Recommendations for Mitigation, by Burton McCollum, K. H. Logan; Technologic Paper No. 60, Microstructural Changes Accompanying the Annealing of Cast Bronze, by Henry S. Rawdon; Technologic Paper No. 64, Determination of Barium Carbonate and Barium Sulphate in Vulcanized Rubber Goods, by John B. Tuttle; Technologic Paper No. 65, Determination of Oil and Resin in Varnish, by E. W. Boughton; Technologic Paper No. 66, Detection of Resin in Drier, by E. W. Boughton; Technologic Paper No. 67, Some Qualitative Tests for Gum Arabic and Its Quantitative Determination, by C. E. Waters, J. B. Tuttle; Technologic Paper No. 69, Determination of Carbon in Steels and Irons by Direct Combustion in Oxygen at High Temperatures, by J. R. Cain, H. E. Cleaves; Bulletin No. 3, Calculation of the Maximum Force Between Two Coaxial Circular Currents, by Frederick W. Grover; Construction of Primary Mercurial Resistance Standards, by F. A. Wolff, M. P. Shoemaker, C. A. Briggs; Note on the Resistance of Radio-telegraphic Antennas, by L. W. Austin; A Method of Measuring Earth Resistivity, by Frank Wenner; A New Relation Derived from Planck's Law, by Paul D. Foote.

NEWS NOTES

ILLUMINATION.

SPOKANE, WASH.—Plans are completed for the ornamental lighting system for Sprague avenue, Bernard to Madison streets, to cost $48,000.

PHOENIX, ARIZ.—The work of installing ornamental electric lighting standards on West Washington street is to be carried on at the same time as the paving is being done.

RIVERSIDE, CAL.—The contract of Fred Schupbach for the installation of single light concrete posts on Robusta street has been accepted. Posts will be furnished and installed for $11 each.

VENTURA, CAL.—The first decisive step toward municipal ownership of the electric lighting system has been taken by the city trustees. A committee has been appointed and given power to secure plans and specifications for an electric plant.

HILO, HAWAII.—Work will be started shortly on the construction of a Hilo gas plant, if the plans of E. J. Smith, former superintendent of the Hawaii Telephone Company do not miscarry. The gas company will operate under the John T. Baker franchise.

SAN GABRIEL, CAL.—Application has been made to the board of trustees for a 40 year franchise granting right to lay a system of gas pipes for carrying gas in this city. Sealed bids will be received at the office of the city clerk for such a franchise up to May 9th.

SANTA BARBARA, CAL.—Ornamental concrete lighting standards, instead of the present metal ones for State street, from Arlington to the beach, and the placing of the present standards on Carrillo and Figueroa streets is under consideration by the city council.

LOS ANGELES, CAL.—An ordinance declaring the intention of the city council to order the necessary cast iron lighting posts and appliances to be installed and maintained for a period of one year for the lighting of Wilshire boulevard and Park View street, has been passed.

FLORENCE, ARIZ.—Bonds in the amount of $50,000 have been voted for a new municipal waterworks and electric lighting plant by the citizens of Florence. The town will buy electric power from the state, and a transmission station will be installed in connection with the new water plant.

SEATTLE, WASH.—Plans have been outlined by the city light department for the construction of an addition to the Lake Union auxiliary steam power plant to cost about $250,000. The additional unit will have a capacity of 13,000 horsepower and will be located north of the present building. Plans for the structure will be prepared by City Architect Daniel Huntington, while the machinery plans will be under the supervision of Superintendent of Light and Power J. D. Ross.

SALT LAKE CITY, UTAH.—Secretary of State David Mattson has proposed to the Utah state capitol commission that this magnificent new building be illuminated by means of flood lighting system at the time of its dedication and thereafter. W. D'A. Ryan has examined the building and pronounced it particularly well adapted to the installation of a flood lighting system. The commission is favorably impressed with the suggestion made by Mr. Mattson regarding it as a much more modern and more effective way of illuminating a building than with the old system of lights on the building itself. In addition it is proposed to install a thoroughly modern system of lighting for the capitol grounds.

TRANSMISSION.

LOS ANGELES, CAL.—Actual construction of the municipal power distributing system in Highland Park, Garvanza and East Los Angeles district will begin immediately, it has been announced.

SAN BERNARDINO, CAL.—It is probable that the Santa Fe railroad will erect a private power plant in the local yards to supply power for its properties here. A private water system is also considered.

LOS ANGELES, CAL.—A permit has been issued for the erection by the water department of a municipal power plant at St. John and Holly streets. The building will be a three-story concrete structure to cost about $60,000.

MULLAN, IDAHO.—J. L. Martin, president and general manager of the Carney Copper Company, states that the company is negotiating for electric power and a compressor which is to be installed as soon as the snow will permit.

LOS ANGELES, CAL.—Acting Mayor Betkouski has issued a public statement in which he asserts that the council does not intend to ask another bond issue as rumored to complete the municipal power project, as the money is now in the treasury to do all the work promised.

PORTLAND, ORE.—The elimination of all overhead electric light and telephone wires in the central East Side is to be proposed by City Commissioner Daly. He has asked City Attorney La Roche to prepare an ordinance requiring the replacement of the present overhead system with underground lines.

MOGOLLON, N. M.—The installation of a power plant on the mesa is engaging the attention of the management of various companies operating in Mogollon. The construction of power houses, removal and re-installing of machinery, and construction of power lines will require less than a month to place all in commission for resumption of mining and milling.

TURLOCK, CAL.—Engineer Meikle has submitted a preliminary estimate of the cost of producing power in the Turlock Irrigation District for drainage purposes, as follows: 4 units of 400 h.p. each; foundations, structures, $40,000; turbines, generators, complete, $36,000; transformers, $6000; transmission line, 40 miles $40,000; installation of 50 pumps $25,000; contingencies, $22,000. Total $169,000.

KELSO, WASH.—The North Coast Power Company, with offices in the Pittock block, Portland, is constructing a seven-mile transmission line from Kelso westerly to serve Diking District No. 1, in which a pumping plant of 150 h.p. is being installed. By this extension two other diking districts on the delta between the Columbia and Cowlitz rivers are to be supplied with power for pumping water. Surveys for the two new districts have been made by F. M. Lane, engineer, Kalama.

SALT LAKE CITY, UTAH.—Application has been filed for 10 cubic feet of water per second from the North and South branches of the North Fork Creek in Utah county for power purposes by John R. Stewart of Provo, Utah. The application sets forth that a dam and pipe line and water power plant will be installed for the purpose of supplying electricity and for lighting and power purposes in Utah and Wasatch county. The water, after being used will be returned to the Provo river.

SALT LAKE CITY, UTAH.—The Utah Power & Light Company, through their tax agent, C. M. Brown, has submitted to the Utah State Board of Equalization schedule of its taxable property in the state, together with a statement this company owns properties to the value of $5,472,890 in the state of Utah and in addition has leased from the Utah Light & Traction Company property with a total value of $3,424,-

055. This company has the largest valuation of any public utility company in the state.

PHOENIX, ARIZ.—F. A. Ward, acting superintendent of the Gila River Indian Reservation, has been conferring with the state board of control relative to conditions under which a right of way would be furnished across the reservation for the proposed power line to Florence and Florence state prison. The legislature has made an appropriation of $19,400 for the construction of this line to connect the power plant and line of the reclamation service and water users. The power will be utilized for pumping and to supply lights. It is probable that work will begin at an early date.

TELEPHONE AND TELEGRAPH.

YUMA, ARIZ.—W. N. Bunton, manager of the local telephone exchange, is considering establishing an exchange at Somerton.

TUCSON, ARIZ.—Immediately upon the completion of the new telephone exchange building being built by the Mountain State Telephone Company the work of installing entirely new and modern equipment will begin.

GARFIELD, WASH.—The trustees of the local telephone system have two offers from telephone men to buy the local plant and install a new system. J. H. Horton, E. J. Byrne and S. A. Manring will canvass the stockholders in regard to the proposition.

PASCO, WASH.—The Pacific States Telephone & Telegraph Company has bought out the Twin City Telephone Company of this city, and will soon take charge of the local exchange. The Twin City Telephone Company has been operating in this valley for about ten years. The long distance exchange which was recently moved from this city to Kennewick for the local business of the Columbia Valley, will be returned to Pasco, where a large, modern structure awaits the new company.

RICHMOND, CAL.—A surprise was sprung at a recent meeting of the city council when two bids for a contract for a telephone franchise for 49 years came up. The Pacific States Telephone & Telegraph Company, which had applied for the franchise, sent in a bid of $100 for the contract. G. L. Fitz, representing Wm. O. Scott of San Francisco, offered $200. The Pacific company countered with a bid of $225 and was awarded the franchise. The city will receive 2 per cent of the company's earnings, estimated at $125,000 per annum.

TRANSPORTATION.

EUGENE, ORE.—Extension of the Oregon Electric Railway from Eugene to Springfield, a distance of about four miles, is a possibility of the coming summer.

ALBUQUERQUE, N. M.—A definite movement has been made for the extension of street car service on North Fourth street to serve the district within the city limits and extending to the U. S. Indian School.

MEDFORD, ORE.—President S. S. Bullis of the Southern Oregon Traction Company has submitted a proposition to the people of Medford, involving the extension of the company's electric line 10 miles to the Blue Ridge mine. The county will give all possible assistance and there will be no trouble securing franchises.

PENDLETON, ORE.—An electric road from Pendleton to Walla Walla and from Cold Springs Landing through Pendleton to Bingham Springs is an undertaking projected by an association of capitalists represented by C. W. Lefler, formerly a farmer in the Cold Springs country. It is understood E. W. McComas of Pendleton is connected with the undertaking.

REDLANDS, CAL.—The railroad committee of the chamber of commerce has been directed to negotiate with the president of the Pacific Electric Railway in regard to extending the P. E. system to the Yucaipa valley. It was stated that the request for a main line extension of the Southern Pacific through Redlands has been referred to the general manager of the road.

FRESNO, CAL.—The directors of the Fresno, Hanford and Summit Lake interurban Railway Company met recently and formally went out of existence. Between 4000 and 5000 railroad ties, the only assets of the company, were turned over to Charles S. Lee, the secretary, who served for five years without compensation. It was decided at the meeting to return all of the deeds in this and Kings counties that were received gratuitously and to attempt to secure financial returns on the rights way which were purchased when the plan was started to construct an electric road out of Fresno. The directors present at the meeting were: W. M. Giffen, W. D. Mitchell, A. V. Taylor, W. J. Kittrell, C. R. Cutten, F. J. Haber and H. P. Brown. Nearly all of the stock is now in the hands of Brown, who besides being financially interested in the road, has acted in the capacity of attorney.

WATERWORKS.

OATMAN, ARIZ.—The board of supervisors has granted a franchise to the Oatman Water Company.

RENTON, WASH.—The city council will probably engage an engineer to make an investigation of the water plant here with a view to enlarging it.

CANBY, ORE.—The city council has fixed May 19th as the date on which to vote on the bond issue of $18,000 which is required to secure a first-class water system.

CALEXICO, CAL.—The board of trustees will receive sealed bids up to April 4th for furnishing pipe and valves for the construction of extensions to the local water system.

GOLDENDALE, WASH.—The application of John Thams to construct and maintain pipe lines across and along streets in the town of Bingen in Klickitat county has been approved.

ROSEBURG, ORE.—A petition has been presented to the Roseburg city council asking that a committee be appointed to investigate the feasibility of constructing a municipal water system.

LAS VEGAS, N. M—J. H. Dockweiler, San Francisco engineer, has undertaken the designing and construction of an irrigation project in San Miguel county near Las Vegas. The work will begin within two months and be completed within a year, at a cost of approximately half a million dollars.

RUPERT, IDAHO.—An ordinance has been passed by the village of Minidoka providing for the issuance and sale of $6000 in bonds to provide for the construction of a municipal waterworks plant. The bonds will be issued in denominations of $500 each, payable January 1, 1916, and redeemable January 1, 1926.

HAMILTON, MONT.—City Clerk Reese has about completed a census of Hamilton and a survey of the water plant. From the data collected a report will be compiled for the city council. The council now has under consideration estimates prepared by a Seattle engineer at a cost of $500. Some are in favor of the installation of a new gravity system drawing the water from Blodgett Creek. This plant it is estimated will cost about $93,000.

PORTLAND, ORE.—R. W. Rea, hydraulic engineer, with offices at 412 Spalding building, has been appointed to the position of project engineer of the Ochoco Irrigation District. This project has recently been organized as an irrigation district under the laws of the state of Oregon, and a complete engineering investigation and estimate of cost will be made at once. Field surveys will commence about April 1. This project was the subject of a preliminary report by a joint government and state survey in 1914-15, in which the total cost was estimated at about $800,000. The construction work, including an earth-fill dam and reservoir, will store about 40,000 acre feet of the waters of Ochoco Creek.

ALPHABETICAL INDEX TO ADVERTISERS

The letter and number before each name are used in the classified page following

A-1 American Ever-Ready Works of National Carbon Co.. Los Angeles; 755 Folsom St., San Francisco; Seattle.

A-2 Atchison, Topeka & Santa Fe Railway Co..... 673 Market St., San Francisco; 1218 Broadway, Oakland.

B-1 Baker-Joslyn Company.....4–5 71 New Montgomery St., San Francisco; 911 Western Ave., Seattle; 353 E. Second St., Los Angeles.

B-2 Benjamin Electric Manufacturing Co..... 590 Howard St., San Francisco.

B-5 Bridgeport Brass Co..... 10 (See Pierson, Roeding & Co.)

C-1 Century Electric Co..... 2 906 So. Hope St., Los Angeles; 56 Natoma St., San Francisco; 65 Front St., Portland, Ore.

C-3 Crocker-Wheeler Co..... 14 Crossley Bldg., 618 Mission St., San Francisco; 228 Central Avenue, Los Angeles.

C-4 Cutler-Hammer Manufacturing Co..... 579 Howard St., San Francisco; Morgan Bldg., Portland, Ore.; San Fernando Bldg., Los Angeles.

D-4 Davis Slate & Manufacturing Co..... Chicago, Ill.

D-2 Dearborn Drug and Chemical Works..... 13 355 East Second St., Los Angeles; 301 Front St., San Francisco.

E-1 Edison Lamp Works of General Electric Co..... Rialto Bldg., San Francisco; 724 So. Spring St., Los Angeles.

E-2 Edison Storage Battery Supply Co..... 10 441 Golden Gate Ave., San Francisco.

E-3 Electric Agencies Co..... 247 Minna Street, San Francisco; Central Building, Los Angeles.

E-6 Electric Novelty Works..... 533 Mission St., San Francisco.

E-4 Electric Storage Battery Co..... 3 743 Rialto Bldg., San Francisco.

E-5 Electric, Railway & Manufacturing Supply Co..... 13 34 Second St., San Francisco.

F-1 Fairbanks, Morse & Co..... Los Angeles; Portland; 651 Mission St., San Francisco; Seattle; Spokane.

F-3 Federal Sign System (Electric)..... 618 Mission St., San Francisco.

G-1 General Electric Co..... 14 724 So. Spring St., Los Angeles; Worcester Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle; Paulsen Bldg., Spokane.

G-1 General Vehicle Co..... 1117 Van Ness Ave., San Francisco; 331 Wall St., Los Angeles; British Columbia Electric Ry., Ltd., Vancouver, B. C.

H-1 Habirshaw Wire Co..... (See Western Electric Company.)

H-2 Hemingray Glass Co..... 13 330 So. Los Angeles St., Los Angeles; 345 Oak St., Portland; 807 Mission St., San Francisco.

H-5 Hunt, Mirk & Co..... 141 Second St., San Francisco.

H-7 Hurley Machine Co..... New York and Chicago.

I-2 Illinois Electric Co..... 261-263 So. Los Angeles St., Los Angeles.

I-3 Interstate Electric Novelty Co..... 111 New Montgomery St., San Francisco.

L-1 Leahy Manufacturing Co..... Eighth and Alameda St., Los Angeles.

L-2 Locke Insulator Manufacturing Co..... 14 (See Pierson, Roeding & Co.)

M-2 McGlauflin Manufacturing Co..... Sunnyvale, Cal.

M-4 Morse Chain Co..... 11 Monadnock Bldg., San Francisco.

M-3 Moore & Co., Charles C..... 3 Van Nuys Bldg., Los Angeles; Spalding Bldg., Portland; Kearns Bldg., Salt Lake City; Sheldon Bldg., San Francisco; Mutual Life Bldg., Seattle; Santa Rita Hotel Bldg., Tucson.

N-1 Nason & Co., R. N..... 151 Potrero Ave., San Francisco.

N-6 National Carbon Company..... Cleveland, Ohio.

N-2 National Conduit & Cable Co., The..... Trust and Savings Bldg., Los Angeles; Rialto Bldg., San Francisco.

N-3 National Lamp Works of G. E. Co..... (All Jobbers.)

N-4 New York Insulated Wire Co..... 3 629 Howard St., San Francisco.

N-5 Northwestern Pacific Railroad..... 808 Phelan Bldg., San Francisco.

O-1 Okonite Co. (The)..... 14 (All Jobbers.)

P-1 Pacific Electric Manufacturing Co..... 80 Tehama St., San Francisco.

P-2 Pacific States Electric Co..... 2 236-240 So. Los Angeles St., Los Angeles; 90 Seventh St., Portland; 200-210 Twelfth St., Oakland; 575 Mission St., San Francisco; 307 First Ave. So., Seattle.

P-4 Pelton Water Wheel Co..... 2 2219 Harrison St., San Francisco.

P-5 Pierson, Roeding & Co..... 10 Pacific Electric Bldg., Los Angeles; Rialto Bldg., San Francisco; Colman Bldg., Seattle.

P-7 Pittsburgh Piping & Equipment Co..... 14 Monadnock Bldg., San Francisco.

S-1 Schaw-Batcher Company, Pipe Works, The..... 10 211 J St., Sacramento; 356 Market St., San Francisco.

S-3 Simplex Electric Heating Co..... 14 612 Howard St., San Francisco.

S-4 Southern Pacific Co..... 10 Flood Bldg., San Francisco.

S-5 Sprague Electric Works..... 13 Rialto Bldg., San Francisco; Colman Bldg., Seattle; Corporation Bldg., Los Angeles; Electric Bldg., Portland; Paulsen Bldg., Spokane.

S-6 Standard Underground Cable Co..... 3 First National Bank Bldg., San Francisco; Hibernian Bldg., Los Angeles; Yeon Bldg., Portland; Central Bldg., Seattle, Wash.

T-1 Thomas & Co., R..... (See Western Electric Co.)

T-2 Tubular Woven Fabric Company.....4–5 Pawtucket, R I.

W-1 Wagner Electric Manufacturing Company ..... St. Louis, Mo.

W-2 Western Electric Co..... Eighth and Santee Sts., Los Angeles; 1901 Telegraph Ave., Oakland, Cal.; 680 Folsom St., San Francisco; 907 First Ave., Seattle; 45 North Fifth St., Portland, Ore.

W-4 Westinghouse Electric and Manufacturing Co..... 6 50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; 165 Second St., San Francisco; Second and Cherry Sts., Seattle; Paulsen Bldg., Spokane.

W-5 Westinghouse Machine Co..... 141 Second St., San Francisco.

W-6 Westinghouse Lamp Co..... (See Westinghouse Electric & Manufacturing Co.)

W-8 Western Pipe & Steel Co..... 444 Market St., San Francisco; 1758 North Broadway, Los Angeles.